THE

POPULAR SCIENCE MONTHLY.

FEBRUARY, 1895.

STUDIES OF CHILDHOOD.

VI.—FIRST ATTACKS ON THE MOTHER TONGUE.

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IN the following paper I shall pass by the first stage of infant phonation, the babbling or singing of the first year which precedes and prepares the way for true baby-speech. A full account of this pre-linguistic articulation will be found in Preyer's well-known volume.

This learning of the mother tongue is one of the most instructive and, one may add, the most entertaining chapters in the history of the child's education. The brave efforts to understand and follow, the characteristic and quaint errors that often result, the frequent outbursts of originality in bold attempts to enrich our vocabulary and our linguistic forms—all this will repay the most serious study while it will provide ample amusement.

As pointed out above, the learning of the mother tongue is essentially the work of imitation. The process is roughly as follows: The child hears a particular sound used by another, and gradually associates it with the object, the occurrence, the situation, with which it again and again occurs. When this stage is reached he can understand the word-sound as used by another, though he can not as yet use it. Later (by a considerable interval) he learns to connect the particular sound with the appropriate vocal action required for its production. As soon as this connection is formed, his sign-making impulse imitatively appropriates it by repeating it in circumstances similar to those in which he has heard others employ it.

The imitation of others' articulate sounds begins very early, and long before the sign-making impulse appropriates them as true words. The impulse to imitate others' movements seems first to come into play about the end of the fourth month, and traces of imitative movements of the mouth in articulation are said to have been observed in certain cases about this time. But it is only in the second half year that the imitation of sounds becomes clearly marked. At first this imitation is rather of tone, rise and fall of voice, apportioning of stress or accent, than of articulate quality; but gradually the imitation takes on a more definite and complete character.*

Toward the end of the year in favorable cases true linguistic imitation commences—that is to say, word-sounds gathered from others are used as such. Thus a boy of ten months would correctly name his mother "mamma," his aunt "addie" (aunty), and a person called Maggie "Aggie." † This imitative reproduction of others' words synchronizes roughly at least with the first onomatopoetic imitation of natural sounds.

As is well known, the first tentatives in the use of the common speech forms are very rough. The child, in reproducing, transforms, and these transformations are often curious and sufficiently puzzling.

The most obvious thing about these first infantile renderings of the adult's language is that they are a simplification. To begin with, a child is at first incapable of reproducing the complex sound structures which we call a word. He tends to cut it down. At the start, indeed, it seems almost a general rule that the word is reduced to a monosyllabic form. Thus biscuit becomes "bik," candles "ka," bread and butter "bup" or "bu," and so forth.

The formidable word periwinkle was shortened to "pinkle," and the no less difficult handkerchief was reduced by the eldest child of a family to "hancisch," by the next two to "hamfisch," and by the last two to "hanky."

There seems to be no simple law governing these reductions of verbal masses. The accentuated syllable, by calling for most attention, is commonly the one reproduced, as when nasturtium became "turtium." The initial and final sounds seem to have an advantage in this competition of sounds, the former as being the first (compare the way in which we note and remember the initial sound of a name), the latter as the last heard and therefore best retained. The lingual facility of the several sound-combinations, and the consequent interest of a quasi-æsthetic kind in

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* Preyer's boy gave the first distinct imitative response to articulate sound in the eleventh month. This is, so far as I can ascertain, behind the average attainment.

† Tracy. The Psychology of Childhood, p. 71.

these combinations, probably have an influence in determining what look like the capricious preferences of the child.*

Such simplification of word-forms is soon opposed and largely counteracted by the growth of a feeling for the general form of the word, including the degree of its syllabic complexity, as well as the distribution of accent and the accompanying modulations of tone or pitch. The child's first imitations of the sounds, e. g., "all gone" by "a-a," or "a-ga," with rising and falling inflection, illustrate the co-operation of this feeling. Hence we find, in general, an attempt to reproduce the number of syllables with the proper distribution of accent. Thus biscuit becomes "bítchic"; cellar, "sítto"; umbrella, "nobélla"; elephant, "étteno" or (by a German child) "ewebón"; kangaroo, "kógglegoo"; hippopotamus, "ippen-pótany"; and so forth.†

Along with the cutting down of the syllabic series there goes from the first a considerable alteration of the single constituent sounds. The vowel sounds are rarely omitted, yet they may be greatly modified, and these modifications occur regularly enough to suggest that the child finds certain nuances of vowel sounds comparatively hard to reproduce. Thus the short *ă* in hat and the long *i* (*ai*) seem to be acquired only after considerable practice. Many of the consonantal sounds, as the sibilants *s*, *sh*, the liquids *l*, *r*, the aspirates *h*, *th*, and others, as *j* and, in rare cases at least, *g*, appear to cause difficulty at the beginning of the speech period. Such sounds are frequently dropped, no other sound being substituted, and this holds good especially when the difficult sound is in combination with another which can be articulated. Thus in the early stages poor becomes "poo"; look, "ook"; stair, "tair"; trocken (German), "tokko"; dance (sibilant), "dan"; schlafen (German), "lafen." Along with these omissions there go curious substitutions, presumably of easier sounds, but not necessarily of sounds which strike our ear as similar. Thus drum is changed into "gum," whereas by another child gum is given as "dam"; thread is given as "shad"; trop (French) as "crop"; pussie as "poofee"; sleepy as "feepy"; Lampe (German) as "Bampe"; bannisters as "bannicars."‡

These substitutions illustrate the growing feeling for sound-

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* Recent psychological experiments show that similar influences are at work when a person attempts to repeat a long series of verbal sounds, say ten or twelve nonsense syllables.

† Here again we see a similarity between a child's repetition of a name heard and an adult's attempt to repeat a long series of syllabic sounds. In the latter case also there is a general tendency to preserve the length and form of the whole.

‡ It has been noted by Sir F. Pollock that sometimes a consonantal sound is introduced where there was none in order to assist in the pronunciation of an initial vowel sound which by itself would be difficult.

form, that is, for the length of the sound-names and the number of principal sound-elements, together with the distribution of voice-stress or accent. Little heed is paid at first to the articulate quality of the sounds. Thus certain sounds, as the labials, are used as drudges and made to stand for a great diversity of sound. Sometimes a guttural sound, as *k*, is put to a like general vicarious service.

How much more important is the general form of the sound-name than the particular order of sounds is seen in the fact that after articulation has become differentiated and the several sounds are repeated with an approach to accuracy, the order is frequently altered. An early example of such transposition noted in the case of one child was the use of "hoogshur" for sugar.

One very interesting feature in these transformations is the strong tendency to reduplication. We notice the tendency to repeat sounds in the first "la-la" stage of articulation, and a like tendency shows itself in the later linguistic stage. Monosyllables are frequently doubled, as in the familiar "gee-gee," "ba-ba," "ni-ni" (nice thing). Some children frequently turn monosyllables into reduplications, making book "boom-boom," and so forth. It is, however, in attempting dissyllables that the reduplication is most common. Thus naughty becomes "na-na"; faster, "fa-fa"; Julia, "dum-dum," and so forth, where, the repeated syllable serves to retain something of the original word-form. In some cases the second and unaccented syllable is selected for reduplication, as in the instance quoted by Perez—"peau-peau" for chapeau.

These early reduplications, which, as is well known, have their parallel in many of the names of the languages of savage tribes,* are sometimes said to be the result of a kind of physiological inertia, the tendency to go on doing what has been begun. But it is probable that the repetition of a sound gives pleasure to the child as a form of sound-harmony or assonance. This supposition is borne out by the fact that the child, in repeating the words uttered by others, frequently assimilates two sounds. Thus he will sometimes alter the first of two sounds so as to assimilate it to the second. In one case thick was pronounced as "kik," and the name Anna received an initial consonant so as to become the reduplication "Na-na." In some cases assonance is secured by altering the final sound. "If" (writes a mother) "a word began with a labial, he generally concluded it with a labial, making bird, for example, 'bom.' In certain instances even the vowel sounds will be modified so as to produce a kind of assonance, as when 'bonnie Dundee' was rendered by 'bun dun.'"

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* See Tylor, Primitive Culture, vol. i, p. 198.

Along with this tendency to reduplication we see a disposition to use particular syllabic sounds, as the final "ie." Thus sugar becomes "sugie"; picture, "pickie"; and so forth. One child was so much in love with this syllable as to prefer it to the common repetition of sound in onomatopoetic imitation, naming the hen not "tuck-tuck," as one might expect, but "tuckie."

I have here given only a very rough account of children's first tentatives in the use of their mother tongue. As yet the facts do not admit of an exact general description. As already suggested, the seizing of the precise shade of an infantile vowel or consonant requires the finely trained ear, and probably a good deal of this part of child observation will have to be reconsidered.*

The facts being as yet but imperfectly observed and classified, it would be premature to offer anything in the way of a complete and final explanation. A difficulty here arises from the circumstance already noted that, according to Preyer, the child in his spontaneous babbling produces most if not all of our common language sounds and others too. This may turn out to be an exaggeration; yet at any rate it is a fact that certain sounds, as *l* and *r*, which occur in the first impulsive babbling, appear to give difficulty later on. How comes this to pass? In order to open up the way to an answer we must look for a moment a little more closely at the process of imitative speech. The later linguistic utterance of a sound differs from and is a much more complex affair than the earlier and impulsive utterance. It is the result of a volition which involves a mental association between the ear's impression of a particular sound, or the idea answering to this, with the idea of the required vocal or articulatory action. Thus a child could not say "poo," in imitation of his nurse's "poo," till the hearing of this sound had got connected, by means of nervous attachments in the brain, with an idea or representation of what its larynx and lips have to do in uttering this sound "poo." Nor could he utter it alone in order to name an object until the *idea* of the sound had entered into this connection.

Now a child might go on hearing the sounds of others forever and never be able to speak, unless he happened by some fortunate circumstance to produce the requisite articulate movements and so find out how the several varieties of sound are obtained. And this is precisely what the early aimless and largely emotional babbling effects. It makes the child acquainted with his own articulate powers, their modifications, and the particular sound-effects which respectively follow these.

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* One of the most painstaking attempts to describe infantile sounds with scientific exactness is that of Sir F. Pollock in his notes On an Infant's Progress in Language. Mind, vol. iii, p. 392 *seq.*

This being so, the reason why a child imitates some of our language sounds correctly, others not, is somewhat doubtful. Thus it may arise because the articulatory apparatus has lost a part of its primordial skill; or because among the sounds which have to be reproduced and which prompt and guide the articulatory movements, some are better singled out and remembered than others; or again, because, owing to the unequal frequency of occurrence of certain sounds, the central nervous connections and corresponding mental association involved are established more quickly in the case of certain sounds than of others. It seems to be commonly held that the first is at all events the main reason, and this conclusion is supported by the fact that all children alike appear to find certain sounds (the labials) easy and others difficult. At the same time it is pretty certain that the environment lends material help in determining unknowingly what sounds shall be first grasped and reproduced. It may be added that the child's preferential interest in certain sounds and sound combinations, as well as in certain objects, as nurse, the dog, which it especially wants to name, plays a subordinate part in determining the common order of lingual progress as well as its variations in the case of different children. A lady writes to say that she is often surprised at the appearance of difficult sound combinations in the talk of her boy. When twenty-two months old he mastered the formidable task of saying "scissors," no doubt, as she remarks, owing to the special interest he had developed about this time in cutting up paper.

As already suggested, the liberties which the child allows himself in using our speech are of philological interest. The subject has been touched on by more than one writer. The phonetic reductions, substitutions, and transpositions of baby-language appear to have their counterpart in the changes which go on in the history of languages. Thus M. Egger points out that when a child says "crop" for "trop," "cravailler" for "travailler," he is reproducing the change which Latin words have undergone in becoming French, as when "tremere" is transmuted into "craindre." Pollock reminds us that when his daughter uses *d* for the unmanageable *r*, she is reversing the process by which the Bengalee transforms the Sanskrit *d* into an *r* sound. The reduplications again, and the use of certain final syllables, as the caressing diminutive "ie," appear to reflect habits of adult language. A further working out of those analogies belongs to the sciences of phonetics and linguistics.*

* Children's defective pronunciation has been elaborately compared by Preyer with abnormal speech defects (*op. cit.*, 18 cap.). There seems, no doubt, to be a certain resemblance between the two; yet Preyer's attempts to show a complete parallelism are somewhat forced.

As I have dwelt at some length on children's defective articulation, I should like to say that their early performances, so far from being a discredit to them, are very much to their credit. I, at least, have often been struck with the sudden bringing forth without any preparatory trial of difficult combinations, and with a wonderful degree of accuracy. Indeed, the precision which a child, even in the second year, will often give to our vocables is quite surprising, and reminds me of the admirable exactness which, as I have observed, other strangers to our language, and more especially perhaps Russians, introduce into their articulation, putting our own loose treatment of our language to the blush. This precision, acquired without, as it would seem, any tentative practice, points, I suspect, to a good deal of silent rehearsal, nascent graspings of muscular actions, which are not carried far enough to produce sound.

The gradual development of the child's articulative powers, as represented partly by the precision of the sounds formed, as also by their differentiation and multiplication, is a matter of great interest. At the beginning, when the child is able to reproduce only a small portion of a vocable, there is, of course, but little differentiation. Thus it has been remarked by more than one observer that one and the same sound (so far, at least, as our ears can judge) will stand for different lingual signs, "ba" standing in the case of one child for both basket and sheep ("ba," lamb), and "bo" for box and bottle. Little by little the sounds grow differentiated into a more definite and perfect form; and it is curious to note the process of gradual evolution by which the first rude attempt at articulate form gets improved and refined. Thus writes a mother: "At eighteen to twenty months 'milk' was 'gink,' at twenty-one months it was 'ming,' and at soon after two years it was a sound between 'mik' and 'milk.'" The same child, in learning to say "lion," went through the stages "un" (one year and eight months), "ion" (two years), and "lion" (two years and eight months). Again, to quote one of Preyer's examples, "grosspapa" (grandpapa) began as "opapa," this passed into "gropapa," and this again into "grosspapa." In another case given by Schultze the word "wasser" (pronounced "vasser") went through the following stages: first, "vavaff"; second, "fafaff"; third, "vaffvaff"; "fourth, "vasse"; and fifth, "vasser." In this last we have an interesting illustration of a struggle between the imitative impulse to reproduce the exact sound and the impulse to reduplicate or repeat the sound, this last being very apparent in the introduction of the second *v* and the *ff* in the first stage, in the substitution of the *f*'s for *v*'s under the influence of the dominant final sound in the second stage. The student of the early stages of language-growth might, one imagines, find many sug-

gestive parallels in these developmental changes in children's articulation.

The rapidity of articulatory progress might be measured by a careful noting of the increase in the number of vocables mastered from month to month. Although Preyer and others have given lists of vocables used at particular ages and parents have sent me lists, I have met with no methodical record of the gradual extension of the articulate field. It is obvious that any observations under this head, save in the very early stages, can only be very rough. No observer of a talkative child, however attentive, can make sure of all the word-sounds used. It is to be noted, too, as I have been assured by parents, that a child will sometimes show that he can master a sound, and will even make temporary use of it, without retaining it as a part of the permanent linguistic stock.*

It is now time to pass from the mechanical to the logical side of this early child-language, to the meanings which the small linguist gives to his articulate sounds, and the way in which he modifies these meanings. The growth of child-speech means a concurrent progress in the mastery of word-form and in the acquisition of ideas. In this each of the two factors aids the other, the advance of ideas pushing the child to new uses of sounds, and the growing facility in word-formation reacting powerfully on the ideas, giving them definition of outline and fixity of structure. I shall not attempt here to give a complete account of the process, but content myself with touching on one or two of its more interesting aspects.

I have pointed out that a child, in imitating the speech of others, does so by associating the sound heard with the object, situation, or action in connection with which others are observed to use it. But the first imitation of words does not show that the little mind has seized their full and precise meaning. A clear and exact apprehension of meaning comes but slowly, and only as the result of many hard thought-processes, comparisons, and discriminations.

It is now recognized that a child's first imitative talk, which might be described as monepic or single-worded—as "wow-wow," "dow" (down)—is essentially vague in so far as the word-sound used covers a number of our meanings. Thus "wow-wow" may mean "the dog is there," or "the dog is doing something," or "I

* As samples of the observations the following may be taken: A friend tells me his boy, when one year old, used just fifty vocables. The performances vary greatly. One American girl of twenty-two months had sixty-nine, whereas another, about the same age, had one hundred and thirty-six—just twice the number. A German girl, eighteen months old, is said by Preyer to have used one hundred and nineteen words, and to have raised this to four hundred and thirty-five in the next six months. The composition of these early vocabularies will occupy us presently.

want (or, possibly, don't want) the dog." These words are "sentence-words"—that is, they are meant to convey a whole process of thought. Only the thought is as yet only half formed or germinal in the degree of its differentiation. Thus it is fairly certain that when the child wants you to sit down and says "dow," it does not clearly realize the relation which you and I understand under that word, but merely has a mental picture of you in the position of sitter.

In these first attempts to use our speech the child's mind is innocent of grammatical distinctions. These arise out of the particular uses of words in sentence structure, and of this structure the child has as yet no inkling. If, then, following a common practice, I speak of a child of twelve or fifteen months as *naming* an object, the reader must not suppose that I am ascribing to the baby mind a clear grasp of the function of what grammarians call nouns (substantives). All that is implied in this way of speaking is that the infant's first words are used mainly as recognition signs. There is from the first, I conceive, even in the gesture of pointing and saying "da!" a germ of this naming process.

The progress of this first rude naming or articulate recognition is very interesting. The names first learned are either those of individuals, what we call proper names, as mamma, nurse, or those which, like "bath," "wow-wow," are at first applied to one particular object. It is often supposed that a child uses these as true singular names, recognizing individual objects as such; but this is pretty certainly an error. He has no clear idea of an individual thing as yet; and he will, as occasion arises, quite spontaneously extend his names to other individuals, as we see in his lumping together other men with his sire under the name "papa."

This extension of names or generalizing process proceeds primarily and mainly by the discovery of the likenesses among things, though, as we shall see presently, their connections of time and place afford a second and subordinate means of expansion. The transference of a name from object to object through the discovery of a likeness or analogy has been touched on in another chapter. It moves along thoroughly childish lines, and constitutes one of the most striking and interesting of the manifestations of precocious originality. Yet, if unconventional in its mode of operation, it is essentially thought activity, a connecting of like with like, and a rudimentary grouping of things in classes.

This tendency to comprehend like things or situations under a single articulate sign is seen already in the use of the early indicative sign "atta" (all gone). It was used by Preyer's child to mark not only the departure of a thing, but the putting out of a

flame; later on, for an empty glass with nothing in it. By another child it was extended to the ending of music, the closing of a drawer, and so on. Here, however, the various applications probably answer to a common feeling, that of "all over," and do not involve a proper process of intellectual assimilation or apprehension of likeness.

Coming to what we should call names, we find that the child will often extend a recognition sign from one object to a second, and to our thinking widely dissimilar, object through a vague feeling of analogy. Such extension, moving rather along poetic lines than those of our logical classification, is apt to wear a quaint metaphorical aspect. A star, for example, looked at, I suppose, as a small bright spot, was called by a child an "eye." Dr. Romanes's child extended the word "star," the first vocable learned after "mamma" and "papa," to bright objects generally—candles, gas, flames, etc. Here we have plainly a rudimentary process of classification. Taine speaks of a child of one year who, after first applying the word "fafer" (from "*chemin de fer*") to railway engines, went on to transfer it to a steaming coffee-pot and everything that hissed or smoked or made a noise. Any point of likeness, provided it is of sufficient interest to strike the attention, may thus secure the extension of the name.

As with names of things, so with those of actions. The crackling noise of the fire was called by one child "barking," and the barking of a dog was named by another "coughing." We see from this that the particular line of analogical extension followed by a child will depend on the nature of the first impressions or experiences which serve as his starting point.

A like originality is apt to show itself in the first crude attempt to seize and name the relations of things. The child C—— called dipping bread in gravy, "ba"—bath. Another child extended the word "door" to "everything that stopped up an opening or prevented an exit, including the cork of a bottle and the little table that fastened him in his high chair." The extension of the word "mend" to making and keeping whole or right, which I find to be common among children, is another quaint example of how the child mind first essays to set forth the relations wholeness and its opposite.

In this last instance we see an example of childish concretism, as it has been called—viz., the tendency to make use of a concrete idea in order to express a more abstract idea. Children frequently express the contrast big, little, by the pretty figurative language "mamma" and "baby." Thus a small coin was called by an American child a "baby dollar." Romanes's daughter, named Ilda, pointed out the sheep in a picture as "mamma-ba," and the lambs as "Ilda-ba." It is somewhat the same process when the

child extends an idea obtained from the most impressive experience of childish difficulty—viz., "too big," so as to make it express the abstract notion "too difficult" in general.

In this extension of language by the child we may discern, along with this play of the feeling for similarity, the working of association. This is illustrated by the case of Darwin's grandchild, who, when just beginning to speak, used the common sign "quack" for duck, then extended it to water; following up this associative transference by a double process of generalization, using the sound so as to include all birds and insects on the one hand and all fluid substances on the other.* The transference of the name from the animal to the water is a striking example of the tendency of the young mind to view things which are presented together as belonging one to another and in a manner identical. Another curious instance is given by Prof. Minto, in which a child who applied the word "mambro" to her nurse went on to extend it by associative transference to the nurse's sewing machine, then by analogy applied it to a hand-organ in the street, then through an association of hand-organ with monkey to its India-rubber monkey, and so forth. Here we have a whole history of changes of word-meaning, illustrating in curious equal measure the play of assimilation and of association, and falling within a period of two years.†

There seems to be a like impulse to identify things which are closely conjoined in experience, as the extension of the word "spend" by the boy C—— so as to make it cover the idea of "costing." In like manner a child has been known to use "learn" for teach. In other cases we see a similar tendency to transfer a name from cause to effect, and *vice versa*. Thus, a little girl of four called her parasol when blown by the wind "windy," and the stone that made her hand sore a "very sore stone." In all these cases of transference it is evident that we have to do with two parts of a whole process, two aspects of one relation.

Here, again, one suspects the child is illustrating a common tendency in the growth of language. The etymological connection between the words teach and learn in German (*lehren, lernen*) shows that the human mind is apt to give a common name to closely related things. A west-of-England yokel still talks of "learning me"—i. e., "teaching me."

There is much, indeed, in the whole of these changes introduced by the child into our language which may remind one of the changes which go on in the growth of languages in commu-

* Quoted by Romanes, Mental Evolution in Man, p. 283.

† Logic (University Extension Manuals), pp. 83, 84.

nities. Thus the child's metaphorical use of words, his setting forth of an abstract by some analogous concrete image, has its counterpart, as we all know, in the early stages of human language. Tribes which have no abstract signs employ a metaphor exactly as the child does. Our own language preserves the traces of this early figurative use of words; as in the "imbecile" (weak), which originally meant leaning on a staff, and so forth.* Similarly we may trace in the development of languages the counterpart of these processes by which children spontaneously broaden out the denotation of their names. The word "sun" has only quite recently undergone this kind of extension by being applied to other centers of systems besides our familiar sun. The multiplicity of meanings of certain words, as "post," "stock," and so forth, point to the double process of assimilative and associative extension which we saw illustrated in the use of the child's word "mambro."

The changes here touched upon have to do with what philologists call generalization. As supplementary to these there is in the case of the growth of a community language a process of specialization, as when "physician," from meaning a student of Nature, has come to mean one who has acquired and can practically apply one branch of Nature-knowledge. In the case of the child we have an analogue of this in the gradual limitation of such a sound as "papa" to one individual. The mental process underlying specialization of words—viz., the gradual differentiation or marking off of narrower classes—shows itself in a very interesting feature of child and savage language, viz., the invention of new compound words.

These new compounds are open metaphors. Thus in the case already mentioned the calling of an eyelid an eye-curtain is a metaphorical way of speaking of the lid by likening it to a curtain. Another example is the compound "foot-wing" invented by the child C—— to describe the limb of a seal. A slightly different kind of metaphoric formation is the pretty name tell-wind, which a boy of four years and eight months hit upon as a name for a weather vane.

In these and similar cases there is at once an analogical transference of meaning (e. g., from curtain to lid) or process of generalization, and a limitation of meaning by the appended or qualifying word ("eye")—that is to say, a process of specialization.

In certain cases the analogical extension gives place to ordinary classing. One child, for example, knowing the word steamship, and wanting the name sailing ship, invented the form "wind ship."

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* See Trench's account of poetry in words. On the Study of Words, lecture vi.

It might be supposed that the qualifying or determining word might come just as naturally after the generic name as before it, as in the French *moulin à vent, cygne noir.* I have heard of one child who used the form "mill-wind" in preference to "windmill." It would be worth while to note any similar instances.

In these inventions, again, we may detect a close resemblance between children's language and that of savages. In presence of a new object a savage behaves very much as a child; he shapes a new name out of familiar ones, a name that commonly has much of the metaphorical character. Thus the Aztecs called a boat a "water house"; and the Vancouver islanders, when they saw a screw steamer, called it the "kick-kicke." *

A somewhat different class of word inventions is that in which a child frames a new word on the analogy of known words. The more common case is the invention of new substantives from verbs after the pattern of other substantives. The results are often quaint enough. Sometimes it is the agent who is named by the new word, as when the boy C—— talked of the "Rainer," or the fairy who makes rain. Sometimes it is the product of the action, as when the same child C—— and the deaf-mute Laura Bridgman both invented the form "thinks" for "thoughts." Similarly, a boy of three called the holes which he dug in his garden his "digs." The reverse process, the formation of a verb from a substantive, also occurs. Thus one child invented the form "dag" for striking with a dagger; and Preyer's boy, when two years and two months old, formed the verb "*messen,*" to express "cut," from the substantive *Messer* (a knife). This readiness to form verbs from substantives, and *vice versa,* which is abundantly illustrated in the development of community language, is without doubt connected with the primitive and natural mode of thinking. The object is of greatest interest to a child as to primitive man as an agent, or as the last stage or result of an action.

In certain of these original formations we may detect a fine feeling for verbal analogy. Thus, a French boy, after killing the *limaces* (snails) which were eating the plants in the garden, dignified his office by styling himself a "*limacier,*" where the inventive faculty was no doubt led by the analogy of *voiturier* formed from *voiture.* †

In certain cases these original constructions are of a more clumsy order, and due to a partial forgetfulness of a word and an effort to complete it. The same little boy who talked of his

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* Tylor, Anthropology, chapter v. In the case of the Chinese and of every savage language, the specific or "attributive" word precedes and does not follow the generic or substantive word.

† Compayré, *op. cit.*, page 249, where other examples are given.

"digs," used the word "magnicious" for magnificent. This is a choice example of word transformation. Very probably the child was led by the feeling for the dignity of this termination in other "grand" words, as "ambitious." Possibly, too, he might have heard the form "magnesia" and been influenced by a reminiscence of this sound-complex. The talk of "Jeames," with which Mr. Punch makes us acquainted, is full of just such delightful missings of the mark in trying to reproduce big words.

A DAY'S HUNTING AMONG THE ESKIMOS.*

By FRIDTJOF NANSEN.

KAIAK hunting has many dangers.

Though his father may have perished at sea, and very likely his brother and his friend as well, the Eskimo nevertheless goes quietly about his daily work, in storm no less than in calm. If the weather is too terrible, he may be chary of putting to sea; experience has taught him that in such weather many perish; but when once he is out he goes ahead as though it were all the most indifferent thing in the world.

Let us follow the Eskimo on a day's hunting.

Several hours before dawn he stands upon the outlook rock over the village, and scans the sea to ascertain whether the weather is going to be favorable. Having assured himself on this point, he comes slowly down to his house and gets out his kaiak jacket. His breakfast in the good old days consisted of a drink of water; now that European effeminacy has reached him too, it is generally one or two cups of strong coffee. He eats nothing in the morning; he declares that it makes him uneasy in the kaiak, and that he has more endurance without it. Nor does he take any food with him—only a quid of tobacco.

When the kaiak is carried down to the beach and the hunting weapons are ranged in their places, he slips into the kaiak hole, makes fast his jacket over the ring, and puts out to sea. From other houses in the village his neighbors are also putting forth at the same time. It is the bladder-nose that they are after to-day, and the hunting ground is on some banks nine miles out to the open sea.

It is calm, the smooth sea heaves in a long swell toward the rocky islets that fringe the shore, a light haze still lies over the

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sounds between them, and the sea birds floating on the surface seem double their natural size. The kaiaks cut their way forward, side by side, making only a silent ripple; the paddles swing in an even rhythm, while the men keep up an unbroken stream

SEAL-HUNTING.

of conversation, and now and then burst out into merry laughter. Bird-darts are thrown in sport, now by one, now by another, in order to keep eye and hand in practice. Presently an auk comes within range of one of them; the dart speeds through the air,

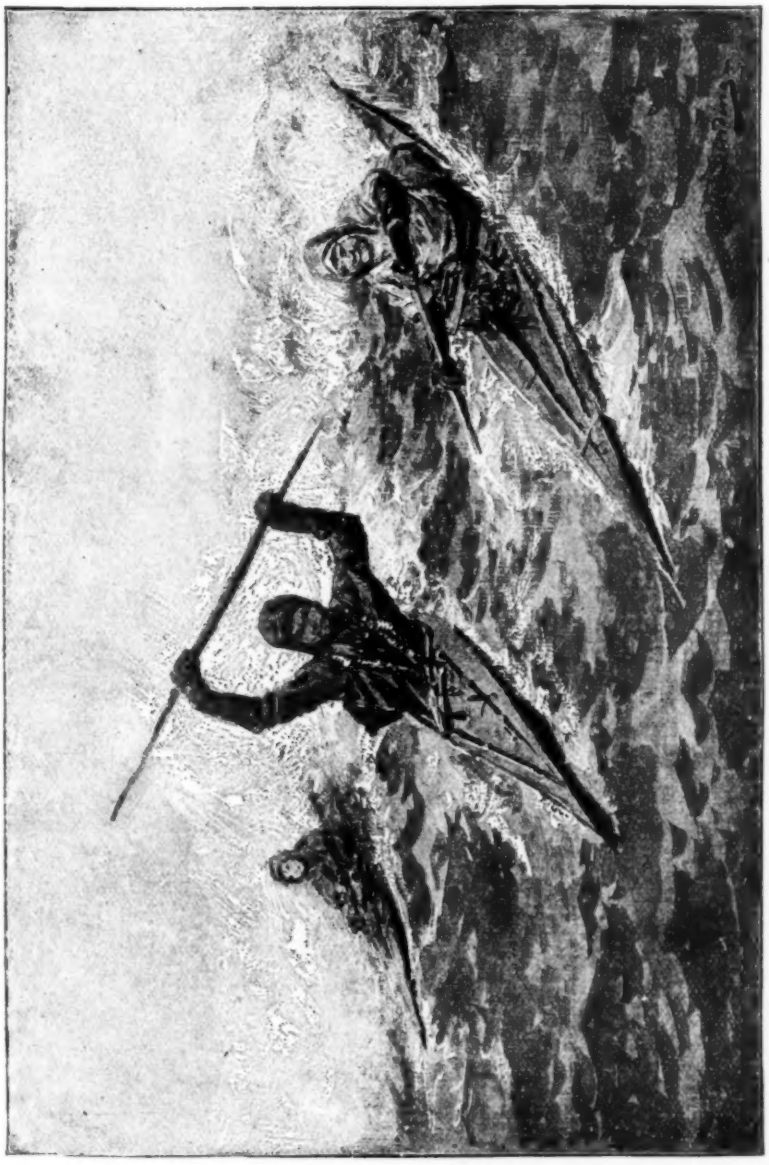
and the bird, transfixed, attempts, with much flapping of wings, to dive, but is held up next moment upon the point of the dart. The point is pulled out, the hunter seizes the bird's beak between his teeth, and with a strong twitch breaks its neck, then fastens it to the back part of the kaiak.

They soon leave the sounds and islets behind them and put straight out to the open sea.

After some hours' paddling, they have at last reached the hunting ground. Great seal heads are seen peering over the water in many directions, and the hunters scatter in search of their prey.

Boas, one of the best hunters of the village, has seen a large he-seal far off, and has paddled toward it; but it has dived, and he lies and waits for its reappearance. There! a little way before him its round black head pops up. He bends well forward, while with noiseless and wary strokes he urges the kaiak toward the seal, which lies peaceful and undisturbed, stretching its neck and rocking up and down upon the swell. But suddenly it is on the alert; it has caught a glimpse of the flashing paddle blade, and now looks straight at him with its great round eyes. He instantly stops paddling and sits motionless, while the way on the kaiak carries it noiselessly forward. The seal discovers nothing new to be alarmed at, and resumes its former quietude. It throws its head backward, holds its snout straight up in the air, and bathes in the morning sun which gleams upon its black, wet skin. In the meantime the kaiak is rapidly nearing; every time the seal looks in that direction, Boas sits still and moves no muscle; but as soon as it turns its head away again, he shoots forward like a flash of lightning. He is coming within range; he gets his harpoon clear, sees that the line is properly coiled upon the stand; one stroke more and it is time to throw—when the seal quietly disappears under the water. It was not frightened, and will consequently come up again at no great distance. He lies still and waits. But the minutes drag on; a seal can remain under water an incredible time, and it seems even longer to one who is waiting for his prey. But the Eskimo is gifted with admirable patience; he lies absolutely motionless except for his head, with which he keeps watch on every side. At last the seal's head once more appears over the water a little way off and to one side. He cautiously turns the kaiak, unobserved by his prey, and once more he shoots toward it over the mirrorlike sea. But suddenly it catches sight of him again, looks at him sharply for a moment, and dives. He knows its habits, however, and at full speed he dashes toward the spot where it disappeared. Before many moments have passed it pops up its head again to look around. Now he is within range: the harpoon is seized and carried back over

his shoulder, then with a strong movement, as if hurled from a steel spring, it rushes whistling from the throwing stick, whirling the line behind it. The seal gives a violent plunge, but at the moment it arches its back to dive, the harpoon sinks into its



BEFORE THE WIND.

side and buries itself up to the shaft. A few convulsive strokes of its tail churn the water into foam, and away it goes, dragging the harpoon line behind it toward the depths. In the meantime Boas has seized the throwing stick between his teeth and, quicker

than thought, has thrown the bladder out of the kaiak behind him. It dances away over the surface of the sea, now and then seeming on the point of disappearing, as indeed it finally does. Before long, however, it again comes in sight, and he chases after it as quickly as his paddle can take him, snapping up on his way his harpoon shaft which has floated to the surface. The lance is laid ready for use. Next moment the seal comes up; infuriated at its inability to escape, it turns upon its pursuer, attacks first the bladder, which it tears to pieces, and then goes straight for the kaiak. Again Boas is within range; the animal arches its back and hurls itself forward with gaping maw, so that the water foams around it. A miss may now cost him his life; but he calmly raises his lance and sends it speeding with terrible force through the seal's mouth and out at the back of its neck. A shudder runs through it, and its head sinks; but the next moment it raises itself perpendicularly in the water, the blood pours frothing from its mouth, it gapes wildly and utters a smothered roar, while the hood over its nose is inflated to an astounding size. It shakes its head so that the lance shaft quivers and waves to and fro; but it does not succeed in breaking it or getting free from it. A moment more and Boas's second lance has pierced through one of its fore flappers into its lungs; the seal collapses and the fight is over. He paddles up to its side, and, as it still moves a little, he gives it a finishing stab with his long-handled knife. Then he sets quietly about pulling out his lances and replacing them in the kaiak, takes out his towing line and blows up his towing bladder, which he fastens to the seal, cuts the harpoon head out and once more makes it fast to the shaft, coils the line on the stand, and takes out a new bladder and places it behind him. Next, the seal's flappers are lashed close to its body with the thong designed for that purpose, and the animal is attached by means of the towing line to one side of the kaiak, so that it can easily be towed along, its head being fastened to the foremost pair of thongs on the deck and its tail to the hindmost. Now Boas is ready to look about him for more game. He is lucky, and has not paddled far before he catches sight of another seal. In an instant he has cast loose the one already killed, which is kept afloat by the towing bladder, while he again sets off in pursuit. This one, too, he kills, after some wary stalking and eager waiting; he takes it in tow and returns for his first prey. The two great animals are fastened one on each side of the kaiak. He has now a good cargo, and can not get very quickly through the water; but that does not prevent him from increasing his bag. As soon as another seal comes in sight those already secured are cast loose, and when the next one is killed it is fastened behind the others. In this way one man

will sometimes come towing as many as four seals, or even more at a pinch.

Tobias, in the meantime, another of the best hunters of the village, has not been quite so fortunate as Boas. He began by chasing a seal which dived and did not come up again within sight. Then he set off after another; but as he is skimming over the sea toward it, the huge head of a hooded seal * suddenly pops up right in front of the kaiak, and is harpooned in an instant. It makes a frightful wallowing and dives, the harpoon line whirls out, but suddenly gets fouled under the bird-dart throwing stick; the bow of the kaiak is drawn under with an irresistible rush, and before Tobias knows where he is, the water is up to his armpits, and nothing can be seen of him but his head and shoulders and the stern of the kaiak, which sticks right up into the air. It looks as if it were all over with him; those who are near him paddle with all their might to his assistance, but with scant hope of arriving in time to save him. Tobias, however, is a first-rate kaiak man. In spite of his difficult position, he keeps upon even keel while he is dragged through the water by the seal, which does all it can to get him entirely under. At last it comes up again, and in a moment he has seized his lance and, with a deadly aim, has pierced it right through the head. A feeble movement, and it is dead. The others come up in time to find Tobias busy making his booty fast, and to get their pieces of blubber from it.† They can not restrain their admiration for his coolness and skill, and speak of it long afterward. Tobias and Boas, however, are the best hunters of the village. It is related of them that, in their younger days, they were such masters of their craft that they even disdained the use of bladders. They made fast the harpoon line round their own waist or round the kaiak ring, and when the harpooned seal was not killed at the first stroke they let it drag themselves and the kaiak after it instead of the bladder. This is looked upon by the Greenlanders as the summit of possible achievement, but there are very few who attain such mastery.

The hunting is often more dangerous than that described above. It will easily be understood that from his constrained position in the kaiak, which does not permit of much turning, the hunter can not throw backward or to the right. If, then, a wounded seal suddenly attacks him from these quarters, it requires both skill and presence of mind to elude it or to turn so quickly as to aim a fatal throw at it before it has time to do him

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* *Hættesæl*, the full-grown male of the *Klapmyts* (bladder-nose). It has a hood over its nose, which it can inflate enormously.

† When a seal is killed, each of the kaiak men in the neighborhood receives a piece of its blubber, which he generally devours forthwith.

damage. It is just as bad when he is attacked from below, or when the animal suddenly shoots up close at his side, for it is lightninglike in its movements, and lacks neither courage nor strength. If it once gets up on the kaiak and capsizes it, there is

A KAIAK MAN ATTACKED BY A WALRUS.

little hope of rescue. It will often attack the hunter under water, or throw itself upon the bottom of the kaiak and tear holes in it. In such a predicament it needs very unusual self-mastery to preserve the coolness necessary for recovering one's self upon even

keel and renewing the fight with the furious adversary. And yet it sometimes happens that after being thus capsized the kaiak man brings the seal home in triumph.

A still more terrible adversary is the walrus; therefore there are generally several in company when they go walrus-hunting, so that one can stand by another if anything should happen. But often enough, too, a single hunter will attack and overcome this monster.

Hitherto the weather has been fine, the glassy surface of the sea has been heaving softly under the rising sun. But in the course of the last hour or two black and threatening banks of clouds have begun to draw up over the southern horizon. Just as Tobias has made fast his seal, a distant roar is heard and a sort of steam can be seen rising over the sea to the southward. It is a storm approaching, and the steam is the flying spray which it drives before it. Of all winds, the Greenlanders fear the south wind (*nigek*) most, for it is always violent and sets up a heavy sea.

The thing is now to get under the land as quickly as possible. Those who have no seals in tow have the best of it, yet they try to keep with the others. One relieves Boas of one of his seals. They have not paddled far before the storm is upon them; it thrashes the water to foam as it approaches, and the kaiak men feel it on their backs, like a giant lifting and hurling them forward. The sport has now turned to earnest; the seas soon tower into mountains of water and break and welter down upon them. They are making for the land with the wind nearly abeam; but they are still far off, they can see nothing around them for the spray, and almost every wave buries them so that only a few heads, arms, and ends of paddles can be seen above the combs of froth.

Here comes a gigantic roller—they can see it shining black and white in the far distance. It towers aloft so that the sky is almost hidden. In a moment they have stuck their paddles under the thongs on the windward side and bent their bodies forward so that the crest of the wave breaks upon their backs. For a second almost everything has disappeared; those who are farther a-lee await their turn in anxiety; then the billow passes, and once more the kaiaks skim forward as before. But such a sea does not come singly; the next will be worse. They hold their paddles flat to the deck and projecting to windward, bend their bodies forward, and at the moment when the white cataract thunders down upon them they hurl themselves into its very jaws, thus somewhat breaking its force. For a moment they have again disappeared—then one kaiak comes up on even keel, and presently another appears bottom upward. It is Pedersuak (i. e., the big Peter) who has capsized. His comrade speeds to his side, but at

the same moment the third wave breaks over them and he must look out for himself. It is too late—the two kaiaks lie heaving bottom upward. The second manages to right himself, and his first thought is for his comrade, to whose assistance he once more

A KAIAK MAN RESCUING A COMRADE.

hastens. He runs his kaiak alongside of the other, lays his paddle across both, bends down so that he gets hold under the water of his comrade's arm, and with a jerk drags him up upon his side, so that he too can get hold of the paddle and in an instant raise

himself upon even keel. The water-tight jacket has come a little loose from the ring on one side and some water has got in; not so much, however, but that he can still keep afloat. The others have in the meantime come up; they get hold of the lost paddle, and all can again push forward.

It grows worse and worse for those who have seals in tow; they lag far behind, and the great beasts lie heaving and jarring against the sides of the kaiaks. They think of sacrificing their prey, but one difficult sea passes after another, and they will still try to hang on for a while. The proudest moments in a hunter's life are those in which he comes home towing his prey, and sees his wife's, his daughter's, and his handmaiden's happy faces beaming upon him from the shore. Far out at sea he already sees them in his mind's eye, and rejoices like a child. No wonder that he will not cast loose his prey save at the direst pinch of need.

After passing through many ugly rollers, they have at last got under the land. Here they are somewhat protected by a group of islands lying far to the southward. The seas become less violent, and as they gradually get farther in they push on more quickly for home over the smoother water.

In the meantime the women at home have been in the greatest anxiety. When the storm arose they ran up to the outlook rock or out upon the headlands, and stood there in groups gazing eagerly over the angry sea for their sons, husbands, fathers, and brothers. So they stand watching and shivering, until, with eyes rendered keener by anxiety, they at last discern what seem like black specks approaching from the horizon, and the whole village echoes to one glad shout: "They are coming! They are coming!" They begin to count how many there are; two are missing! No, there is one of them! No, they are all there! They are all there!

They soon begin to recognize individuals, partly by their method of paddling, partly by the kaiaks, although as yet they are little more than tiny dots. Suddenly there sounds a wild shout of joy: "Boase kaligpok!" ("Boas is towing")—him they easily identify by his size. This joyful intelligence passes from house to house, the children rush around and shout it in through the windows, and the groups upon the rocks dance for joy. Then comes a new shout: "Ama Tobiase kaligpok!" ("Tobias too is towing"); and this news likewise passes from house to house. Next is heard: "Ama Simo kaligpok!" "Ama David kaligpok!" And now again comes another swarm of women out of the houses and up to the rocks to look out over the sea breaking white against the islets and cliffs, where eleven black dots can now and then be seen far out amid the rolling masses of water, moving slowly nearer.

At last the leading kaiaks shoot into the little bight in front of the village. They are those who have no seals. Lightly and with assured aim one after the other dashes up on the flat beach, carried high upon the crest of the waves. The women stand ready to receive them and to draw them farther up.

Then come those who have seals in tow; they must proceed somewhat more cautiously. First, they cast loose their prey and see that it comes to the hands of the women on shore. Then they themselves make for the land. When once they have got out of the kaiak they, like the first comers, pay no heed to anything but themselves and their weapons, which they carry to their places above high-water mark. They do not even look at their prey as it lies on the shore. From this time forward all work in connection with the "take" falls to the share of the women.

The men go to their homes, take off their wet clothes, and put on their indoor dress, which, as we have seen, was in the heathen times exceedingly airy, but has now become more visible.

Then at last comes the first meal of the day; but it does not begin in earnest till the day's "take" is boiled and served up in a huge dish placed in the middle of the floor. Then there disappear incredible quantities of flesh and raw blubber.

When hunger is appeased, the women always set themselves to some household work, sewing or the like, while the men give themselves up to well-earned laziness, or attend a little to their weapons, hang up the harpoon line to dry, and so forth.

NATURE'S TRIUMPH.

By JAMES RODWAY, F. L. S.

IN the temperate regions of the world man overcomes Nature, but in the tropics he makes little or no impression. The Indian has lived in the great forest of South America for ages, yet hardly a trace of his presence can be found. The ordinary traveler sees no sign of him for perhaps a hundred miles, and would be inclined to say that nothing but a desolate wilderness had ever existed. Yet, if we believe the early travelers, the coast from the river Orinoco to the Amazon was once fairly well peopled. The powerful Carib—the savage of "Robinson Crusoe"—was guardian of the coast, and strong enough to repel every invasion of the Spaniard, while the gentle Arawak—"Man Friday"—occupied the upper reaches of every little creek.

Even where the country is not deserted the Indian villages are still hid away in the virgin forest, the inhabitants and their palm-covered shelters harmonizing with everything around. Unlike

the clearing of a plantation, they make no impression on the forest; they form a part of one great whole, every portion of which has accommodated itself to every other. Tropical man does not rule Nature, but is himself a part of her great domain.

The old Dutch sugar planter with his slaves made little more impression on the forest than the savage. True, his clearing was larger and lasted as long as his struggle with Nature was kept up; but when, finding out the superior fertility of the coast lands, he abandoned it and retired, the forest quickly incorporated it with herself. For about a hundred miles up the Berbice and Demerara Rivers the banks were once lined with plantations; now, beyond some ten miles, every one of these has reverted to dense forest, here and there only a few negro huts indicating that man still lives there, like the Indian, without making any real impression.

The stages in the onward march of the forest over a clearing are most interesting. Perhaps two or three hundred acres had been planted with sugar canes, and fifty in plantains, vegetables, and fruit. There would be a fair-sized dwelling house, a water or cattle sugar mill, huts for the negroes, and a wharf on the river bank. The planter decided to give up the place, as he had an offer of a more fertile piece of land on the coast. Taking away everything portable, including the machinery of his mill, he abandoned the rest, carried away his negroes, and left the clearing to Nature.

Let us look upon the plantation a year later. Already a thicket has grown up which is only penetrable by the constant use of a cutlass. After a great deal of labor we reach the borders of the once tidy clearing. What a wonderful sight! Along the line of forest trees a dense wall of creepers rises sixty to a hundred feet high, forming an effective veil to the dark arcades beyond. From these stretch out long ropes, twining vegetable serpents, and giants' fingers, all moving toward what was once the open space. Some are hundreds of yards long, rooting at the joints, whence other branches radiate and form the dense obstruction we have cut through.

The creepers, twiners, and scramblers have not yet reached the house, but Nature is at work there also. Round it was once an orchard of oranges, limes, star apples, and other tropical fruit, with a few flowering shrubs. Most of these are now overrun with the blood-sucking loranths—vegetable leeches—which are continually draining their juices and evidently fattening on the spoil. These exotic bushes and trees have no business here; they are intruders. If man protects them and destroys their enemies they can thrive, but if he abandons them they must perish. Perhaps you are thirsty and look for an orange, but among a dozen trees not a single fruit can be found, and never will be again.

Under these trees tall, sturdy grasses rise up to your shoulders and with great straggling bushes do their best to prevent the fruit trees from gaining a living for themselves, much less for the parasites that swarm over their branches.

The house itself is almost hidden in foliage. On the brick pillars wild figs have germinated and already insinuated their aërial roots into every crevice, while their glossy stems and leaves almost cover the sides of the building. Then, that rampant creeper, the cissus (*C. sicyoides*), is running up the walls and over the roof, which it covers entirely. Clearing away the vegetation which blocks the entrance, you find the stairs falling to pieces, and only by climbing can you reach what was once the front door. After hacking with the cutlass, room is made to push through and you enter. But don't be in a hurry; take care of the flooring; hold on to the creepers until you have sounded the boards, or you may fall through. Crash! There goes one foot through the first board. Draw it up and try another. It cracks but does not yield, and as your eyes become accustomed to the half light a dark cave with brown stalactites is dimly seen. These stalactites are the aërial roots of the cissus, which have been thrown straight down through holes in the roof, and now spread great masses of fibers over the floor, some finding their way into cracks and joints and thence to the earth below. In the corners of the rooms are great oval brown masses, the nests of termites or wood ants, the inhabitants of which are hard at work tunneling every board and rafter until they will become so brittle as to almost fall to pieces by their own weight. Ultimately, when the house frame is thus weakened, the structure will be only kept in shape by its wild figs and creeper stems, the roof will fall in, and the whole become an intricate jungle of interlacing stems.

A few years later trees have grown up to smother the creepers, and only an expert can say that a clearing once existed here.

If an estate of several hundred acres can be so easily effaced, what shall we say of the ordinary squatter's clearing? On the upper Demerara River are hundreds of little settlements in the possession of negroes and half-Indians. Some are crowded with fruit trees struggling with a thick and almost impregnable undergrowth, which is partly cleared now and then to admit of picking the fruit. Near the river stands the dwelling house—a shed thatched with palm leaves—on either side of which will be one or two calabash trees to supply the substitute for plates and dishes which is so indispensable. On these grow scarlet rodriguezias and other small orchids, while even a specimen of the "baboon's throat" (*Coryanthes*) or "thick-leaf parasite" (*Oncidium lanceanum*) may have been put up in the forks. If there are any young

girls in the house, there will probably be a few dracænas, crotons, or perhaps a hibiscus planted beside the path from the river.

Immediately behind is the forest, reaching out its hands, as it were, to embrace the little half-clearing. Whiplike extensions of scrambling vines stretch over the fruit trees and bring one after another under their canopy. The occupier of this little paradise sees little of what is going on and cares less. Like the Indian, he considers weeding a part of the woman's duties, while the creole woman has very loose ideas on this matter. If there are children, they crave for fruit, and are disappointed when none is to be obtained; but even if they knew the reason they could hardly be expected to do anything. The man at last begins to see how the jungle is advancing, and looks on helplessly. To fight with such a tangle is too hard for the man of the tropics; he would rather make a fresh clearing. At last the house is surrounded and the creepers run over the thatch. Probably the uprights have already been attacked by wood ants and threaten to give way. A new house must be built, and this can be done better on a fresh clearing; so the place is abandoned, and Nature again triumphs. A few months later and the landing is choked, the house fallen, and the jungle impenetrable.

The plantations before mentioned belonged to the upper districts, and were abandoned a century or more ago. There have been, however, many large estates near the mouths of the rivers and along the coasts given up during the last fifty years. No matter how large the clearing, if it is in the forest region, it must ultimately be obliterated. Here and there a brick chimney is seen peeping above the level of the forest, but otherwise there is not the slightest appearance from outside that this was once a flourishing sugar plantation. Examine it carefully, however, and you will find what at first sight appeared to be virgin forest only "second growth." This consists of fast-growing, soft-wooded trees, which in the struggle for life have outstripped the more hard timber trees of the forest proper.

Cut a way through the dense jungle on the river side, and if you are a skillful bushman the site of the house and buildings may be found. Above everything else stands the brick chimney, but what a transformation! It is so covered with wild fig roots as to be almost indistinguishable, while the top is decorated with an immense bush which will ultimately develop into a tree. Around the base of the shaft the remains of boilers and other ironwork have colored the soil, and among these may be seen broken bricks, slates, and glass. Look round carefully, and perhaps you may find the family burying place. Here are tombs with marble slabs, cracked and broken by the slow but powerful leverage of

the fig roots, and by putting the pieces together you may perhaps read that *Hier legt begraven den Wel Edele Gestrenge Heer* ——. The despotic owner of all he surveyed—land, animals, men, women, and children—is now gone, and Nature has spurned his handiwork under her feet.

Outside the forest region and near the coast is a line of swamps, and on the rich alluvium reclaimed from these the sugar, cotton, and coffee plantations of the present century were established. Several hundred have been abandoned at different times, but these do not become incorporated with the forest. From the swamp they were reclaimed, and to that state they have mostly returned.

When in cultivation the estate is walled in, as it were, with earthen dams on every side, those at the back and front being most important. By means of the former the swamp water is kept out and by the latter the sea, while the inclosed area is freed from the heavy rainfall by means of sluices and draining engines. When abandoned these arrangements soon get out of order. The outfalls are choked, the dams are perforated by crabs or broken down by floods, and soon the ground becomes more and more sodden. The sugar-cane plants which were left in the ground sprout freely, but, as they now have to compete with a rampant host of weeds, they are unable to cover the ground, but grow in isolated patches. This, of course, allows their enemies all the more scope, and the competition soon becomes serious. The delicate Bahama grass (*Cynodon dactylon*) comes first and overruns the surface, but this has soon to give way to a lot of wiry, prickly shrubs which are fitted to grow almost anywhere. These include black sage (*Varronia curassavica*), prickly solanums, sensitive plants, and wild indigo. As they steal their nourishment from the soil, the canes never become strong enough to smother them, but languish more and more until obliged to succumb. By this time the seeds of a number of straggling bushes and trees have found their opportunity, and the clammy cherry (*Cordia*), hog-plum (*Spondias*), and wild fig come up here and there, growing very quickly and partly ousting out the smaller plants. Alongside the draining canals thickets of prickly shrubs and scrambling vines soon make their appearance, and, as they grow, obstruct the outflow of water more and more. Then, as the water rises after a day's rainfall of perhaps seven or eight inches, the front dam is washed away and the sea comes over at the next spring tide, filling the trenches in front with brackish water. The courida (*Avicennia*) and mangrove (*Rhizophora*) which guard the shore now advance, and with them an army of beach weeds, including that triply armed invader, the nicker (*Giulandina bonducella*). Soon crabs perforate every part of the sea dam, and the whole front becomes a great mangrove swamp.

While this transformation has been taking place in front, Nature has not been inactive behind. There is a large body of water in the swamps always trying to find an exit, and it is only by strict attention to the slightest breach that the planter keeps his estate from getting inundated. Now, of course, there is no one to attend to this matter, and when the heavy rains fall the flood carries down the weakened dam and makes a greater inundation behind than there is in front. The canes, which have hitherto managed to exist after a fashion, now rot, and with them go the Bahama grass and some of the other weeds which only live on comparatively dry land. These, however, are soon replaced by a host of sedges, grasses, and marsh shrubs which make as impenetrable a jungle as the others. Now the vegetation forms two distinct zones, that in front comprising littoral plants; and behind, those of the fresh-water savanna.

Rarely, however, is an estate on the coast allowed to revert entirely to its pristine condition, as there is generally a public road to be kept up which necessitates a proper sea dam. It follows, therefore, that the mangrove swamp is kept outside the boundary line and the abandoned plantation is partially drained to prevent danger to the road from floods aback. In such cases the vegetation is not so rampant, but it is still far beyond anything seen in temperate climates. Every trench is filled with water plants, and the land is overrun with sour grass (*Paspalum conjugatum*). This grass, which is the pest of every pasture in the wet season, covers a waterlogged plantation almost to the exclusion of everything else. During the rains it is ahead of everything, and it is only during a drought that it languishes a little. Then, the Bahama grass and a few other weeds find room for a small show, to be again vanquished, however, as the next wet season sets in. Where once was the battlefield of man and Nature is now the scene of an annual struggle between two great armies of plants. Man fought against both, and they maintained a most gallant defense, only retiring inch by inch. Now they have both rushed in to fight each other for the mastery.

For some time after the plantation has been abandoned the lines of the draining trenches, and even the geometrical shape of the cane beds, can still be traced, but when there is nothing in the way of the flood, either in front or behind, these soon fill up or sink to one uniform level. It is, however, sometimes possible to find relics of the plantation buildings, as the *débris* often rises above the level of other portions of the estate. The bricks and all other materials of any value were removed prior to its abandonment, but there were always heaps of rubbish not worth carting away, and these remain, covered with weeds, to tell the investigator of some future age what manner of people lived here. Even if

the whole plantation has become a swamp, these heaps form little islands amid the ooze, and, in a very dry season, when the savanna has been burned, they stand up like the mounds of the Caribs, to which they are somewhat analogous.

To understand this analogy, we must go back to some past age long before the discovery of America. The original coast line of British Guiana is now some twenty miles inland; but ages ago, no doubt, the present sand-reefs were washed by the ocean. The great rivers brought down sand, mud, and vegetable matter in solution, as they do to-day. These suspended and dissolved substances were deposited in the shape of sandbanks and shoals and became little islands. To these the cannibals retired from all enemies, and enjoyed their horrible feasts in seclusion and without fear, in the way so well described by Defoe.

Under mounds of sand, covered with forest trees, the remains of the Carib's feast can still be found and recognized. These mounds are most common in the northwestern district of British Guiana—the *Canibalor Terra* of the early voyagers and the *Caribana* of Raleigh. Some are situated several miles from the present coast line, and were probably occupied for many years, as the heaps of shells, bits of pottery, stone weapons, and, most horrible of all, human bones broken for the marrow, must have taken a long time to accumulate. Now they are hidden in the virgin forest, and only by accident have a few been discovered. Nature has triumphed, and the Carib is virtually extinct.

In one respect the savage leaves a more lasting record of his former presence than the white man. The steel knife or axe crumbles away under the influence of heat and moisture, and even the great iron sugar pan throws off thick flakes of oxide until it falls into dust. But the stone axe of the Indian is as lasting as the rock itself, and might be safely said to be an imperishable record. Gold-diggers not infrequently come upon them at depths of six or eight feet in our river bottoms, and they are found in canal excavations as well as in the cannibal mounds. In Guiana they are not necessarily ancient, as they were in use everywhere up to three centuries ago, and are still utilized in shaping pottery. Even a century ago it would not have been hard to find some of them put to their proper use—i. e., to scrape away the charred portions of wood in excavating a canoe.

Besides the mounds and stone implements, the educated eye sees other evidences of the Indian's presence at some former time. The Arawak in the past, as in the present, generally made his settlement on a sand reef, and hardly a creek is without indications of his former presence. A stranger is so bewildered with the great tangle of vegetation, and the variety of form and color

in leaf and flower, that he can hardly perceive these traces; but the naturalist's attention is arrested at once.

From the creek there is a gentle ascent to a slight elevation, where the aspect of the vegetation differs somewhat from its surroundings. Here is a clump of pineapples, and close by an impenetrable thicket of krattee, the material from which hammock and bow strings were made. Look a little closer, and perhaps a few variegated caladiums or scarlet-flowered belladonna lilies (*Hippeastrum equestre*), or even a specimen of the giant reed (*Gynerium saccharoides*), may be seen. A stranger, seeing the beauty of form and color, might wonder how they came there; but the naturalist can say at once that here, in some past time, was an Indian settlement, and these are his footprints.

It might also be thought from these relics of the red man's presence that he understood the decorative value of plants and flowers. Such, however, is not the case; for, although he formerly painted his skin with red, dark blue, and white pigments, and, like a child, was fond of staring colors, he did not grow these handsome leaves and flowers to satisfy such a taste. He does not wear garlands, although he undoubtedly has a most delicate taste in the arrangement of feathers for his headdress and waist-belt. As for his women, they—with the exception of a bead apron, on which is worked a pretty geometrical pattern—never decorate themselves in any way. Why, then, do they grow these lilies and caladiums? The answer shows one of the most interesting sides of the Indian character.

They are *beenas*, or charms, to make them good hunters, fishermen, or shooters. The beena notion pervades the Indian's whole life, as providing meat is his duty above everything else. There seems to be no rule in regard to the choice of beenas, except that their use must always be painful. The most universal, and that which seems to have a general application, is the nose beena, a whip made of *eta* fiber, which is put up one of the nostrils and drawn through the back of the mouth. This is used when a boy reaches manhood, to make him skillful in all his operations. Then there are particular beenas for every animal—the jaguar, tapir, peccary, labba, and even birds and fishes. The beautiful suffused crimson variety of *Caladium bicolor* is the jaguar beena, and other blotched and spotted kinds and the lilies are used for different quadrupeds. If the Indian hunter fails in shooting a particular animal and returns home without meat, he is dejected, and appears to think some virtue has gone out of him. The beast has got the better of the man, and he must renew his strength. To do this, he digs up a root of caladium or lily, and, after slashing himself with a knife on breast and arms, rubs the acrid juice into the wounds. Of course, the operation is very

painful, but he does not mind that; the more excruciating the torture the better the charm is working. Next day he goes forth into the forest with renewed confidence, and is likely to be more successful on that account alone.

However, we are wandering away from our subject, and must return to the traces of man's presence in the forest. If the little spot on the sand hill has been recently abandoned, a dark patch of humus shows where the *benab* or hut once stood, and this will be covered with prickly solanums and other weeds, from which the bare white sand in the neighborhood is entirely free. Sometimes narrow paths into the forest or down to the creek can still be discerned by the careful observer, even after very long periods, as the comparatively barren sand reef does not obliterate every trace so quickly as does the forest. It may be possible even to find the way to what was once the cassava field—now either an impenetrable jungle or apparently virgin forest. It winds through and under the trees, where a little light has been able to penetrate, obstructed by young trees or crossed by bush-ropes, but fairly conspicuous in the darker arcades. If you succeed in finding the field, and it has been abandoned for only two or three years, the jungle is impenetrable; while after twenty, except for the absence of very large trees, it is unrecognizable.

The plants we have mentioned as indicators of man's presence at some former period are never found truly wild in the forest. They have been—we were going to say cultivated, but that would be a misstatement—grown by the Indians for ages, and are now so thoroughly naturalized as to exist apart from his presence. If the top of a pineapple is thrown down beside the path, it will be sure to grow if there is sufficient light and the soil is porous. It thus becomes an indicator of old tracks over the sand reefs, and will sometimes enable the lost wanderer to retrace his footsteps. Even the forest itself is intersected with tracks which often lead the hunter astray, and give him great trouble to find the right way on his return. Some are almost effaced, others conspicuous for a short distance, and then blocked by some great tree. The path is older than the tree, and yet can be discerned in certain lights, although easily missed when looked for from a different point. Even in returning by the same track the difference in direction will often cause hesitation and doubt.

The ground in the forest is undulating, and if we follow an old track it is always obliterated in the gullies, but may be recovered on the opposite slope. Creeks and small watercourses cross it, or perhaps it stops entirely at the little stream where formerly the Indian embarked in his canoe to reach the great river. No canoe can pass now, and perhaps there is not in existence a single descendant of his tribe. Yet the track is visible,

and above on the hill are pineapples and other relics of his former presence.

On the savannas of the far interior we can also find a few traces of the red man of the past. Here there are no trees, but only a low, scrubby vegetation. Slight elevations here and there are still dotted by the circular dwellings of Macusis, Wapisianos, and Arecunas; but many a mound that was once the site of a village is now deserted, and not a trace of the dwellings remains. Yet, from a distance, dependent on light and shade, indistinct foot-paths can be traced, while on the top the want of even a few scattered plants is an indication to the educated eye that a village once stood there. Then, again, there are little creeks near by, in which stepping-stones have been placed, and on one mound have been seen a number of stones arranged as an oval, which could only have been placed there by man.

Although these faint traces may be discovered when carefully looked for, the general result is a virtual obliteration of man's handiwork. No important buildings of stone have ever been erected in British Guiana, but two brick forts show what would happen if even great buildings were abandoned. One of these was deserted about the year 1740, and the other since 1812. Both have been long since hidden among the trees, and even their ruined walls are overgrown, so that it would only be possible to see them at a great expense of time and labor. Burying-grounds in different parts of the colony are in the same condition, and one in Georgetown, abandoned as late as 1840, and nominally cared for, is covered with vegetation, and its tombs almost hidden. When brought to light, as they are sometimes in the dry season by the withering of the tall grasses and weeds, what a picture of Nature's handiwork is there! Every tomb has been taken over by one or more wild figs, and their aërial roots have insinuated themselves between each brick and slab until the sides are cracked and bulged, and the tops lifted off, broken to pieces, and removed. Man's battle was continuous as long as he lived; after his death Nature triumphed.

In a paper read to the Anthropological Section of the American Association, Dr. Brinton called attention to a number of peculiarities in the human skeleton which had attracted the notice of anatomists, and which had frequently been interpreted as signs of reversion to an apelike ancestry. Most of these, however, can be explained by mechanical function, or excess or deficiency of nutrition; and when they can be so explained, this is the only interpretation they should receive. They can no longer be offered as evidence of the theory of evolution, nor considered as criteria or marks of the human races. The doctor gave a long list of such peculiarities and showed the evidence that they are the results of functional working and pathological causes.

PLEASURES OF THE TELESCOPE.

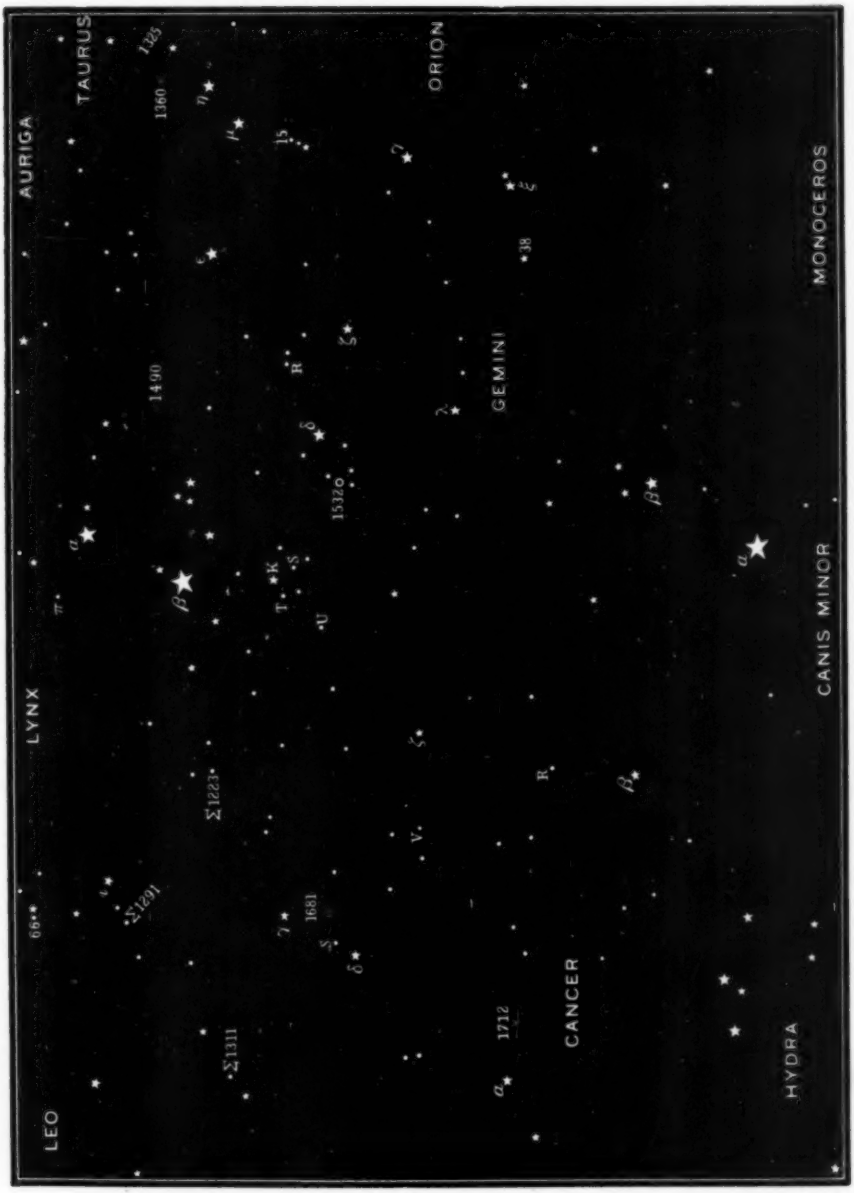
By GARRETT P. SERVISS.

III.—THE STARRY HEAVENS (*continued*).

THE zodiacal constellations of Gemini, Cancer, and Leo, together with their neighbors Auriga, the Lynx, Hydra, Sextans, and Coma Berenices, will furnish an abundance of occupation for our second night at the telescope. We shall begin, using our three-inch glass, with α, the chief star of Gemini (map No. 4). This is ordinarily known as Castor. Even an inexperienced eye perceives at once that it is not as bright as its neighbor Pollux, β. Whether this fact is to be regarded as indicating that Castor was brighter than Pollux in 1603, when Bayer attached their Greek letters is still an unsettled question. Castor may or may not be a variable, but it is, at any rate, one of the most beautiful double stars in the heavens. A power of one hundred is amply sufficient to separate its components, whose magnitudes are about two and three, the distance between them being 5·8″, p. 230°. A slight yet distinct tinge of green, recalling that of the Orion nebula, gives a peculiar appearance to this couple. Green is one of the rarest colors among the stars. Castor belongs to the same general spectroscopic type in which Sirius is found, but its lines of hydrogen are broader than those seen in the spectrum of the Dog Star. There is reason for thinking that it may be surrounded with a more extensive atmosphere of that gaseous metal called hydrogen than any other bright star possesses. There seems to be no doubt that the components of Castor are in revolution around their common center of gravity, although the period is uncertain, varying in different estimates all the way from two hundred and fifty to one thousand years; the longer estimate is probably not far from the truth. There is a tenth-magnitude star, distance 73″, p. 164°, which may belong to the same system.

From Castor let us turn to Pollux, at the same time exchanging our three-inch telescope for the four-inch, or, still better, the five-inch. Pollux has five faint companions, of which we may expect to see three, as follows: Tenth magnitude, distance 175″, p. 70°; nine and a half magnitude, distance 206″, p. 90°, and ninth magnitude, distance 229″, p. 75°. Burnham has seen a star of thirteen and a half magnitude, distance 43″, p. 275°, and has divided the tenth-magnitude star into two components, only 1·4″ apart, the smaller being of the thirteenth magnitude, and situated at the angle 128°. A calculation based on Dr. Elkin's parallax of 0·068″ for Pollux shows that that star may be a hundredfold more luminous than the sun, while its nearest companion may be a body

smaller than our planet Jupiter, but shining, of course, by its own light. Its distance from Pollux, however, exceeds that of Jupiter from the sun in the ratio of about one hundred and thirty to one.



Map No. 4.

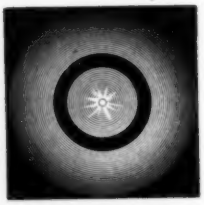
In the double star π we shall find a good light test for our three-inch aperture, the magnitudes being six and eleven, distance 22″, p. 212°. The four-inch will show that κ is a double, magnitudes four and ten, distance 6″, p. 232°. The smaller star

is of a delicate blue color, and it has been suspected of variability. That it may be variable is rendered the more probable by the fact that in the immediate neighborhood of κ there are three undoubted variables, S, T, and U, and there appears to be some mysterious law of association which causes such stars to group themselves in certain regions. None of the variables just named ever become visible to the naked eye, although they all undergo great changes of brightness, sinking from the eighth or ninth magnitude down to the thirteenth or even lower. The variable R, which lies considerably farther west, is well worth attention because of the remarkable change of color which it sometimes exhibits. It has been seen blue, red, and yellow in succession. It varies from between the sixth and seventh magnitudes to less than the thirteenth in a period of about two hundred and forty-two days.

Not far away we find a still more curious variable ζ; this is also an interesting triple star, its principal component being a little under the third magnitude, while one of the companions is of the seventh magnitude, distance 90″, p. 355°, and the other is of the eleventh magnitude or less, distance 65″, p. 85°. We should hardly expect to see the fainter companion with the three-inch. The principal star varies from magnitude three and seven tenths down to magnitude four and a half in a period of a little more than ten days.

With the four or five inch we get a very pretty sight in δ, which appears split into a yellow and a purple star, magnitudes three and eight, distance 7″, p. 206°.

Near δ, toward the east, lies one of the strangest of all the nebulæ. (See the figures 1532 on the map.) Our telescopes will show it to us only as a minute star surrounded with a nebulous atmosphere, but its appearance with instruments of the first magnitude is so astonishing and at the same time so beautiful that I can not refrain from giving a brief description of it as I saw it in 1893 with the great Lick telescope. In the center glittered the star, and spread evenly around it was a circular nebulous disk, pale yet sparkling and conspicuous. This disk was sharply bordered by a narrow *black* ring, and outside the ring the luminous haze of the nebula again appeared, gradually fading toward the edge to invisibility. The accompanying cut gives but a faint idea of this most singular nebula. If its peculiarities were within the reach of ordinary telescopes, there are few objects in the heavens that would be deemed equally admirable.



WONDERFUL NEBULA IN GEMINI (1532).

In the star η we have another long-period variable, which is

also a double star; unfortunately the companion, being of only the tenth magnitude and distant less than 1″ from its third-magnitude primary, is beyond the reach of our telescopes. But η points the way to one of the finest star clusters in the sky, marked 1360 on the map. The naked eye perceives that there is something remarkable in that spot, the opera glass faintly reveals its distant splendors, but the telescope fairly carries us into its presence. Its stars are innumerable, varying from the ninth magnitude downward to the last limit of visibility, and presenting a wonderful array of curves which are highly interesting from the point of view of the nebular origin of such clusters. Looking backward in time, with that theory to guide us, we can see spiral lines of nebulous mist occupying the space that now glitters with interlacing rows of stars. It is certainly difficult to understand how such lines of nebula could become knotted with the nuclei of future stars, and then gradually be absorbed into those stars; and yet, if such a process does not occur, what is the meaning of that narrow nebulous streak in the Pleiades along which five or six stars are strung like beads on a string? The surroundings of this cluster, 1360, as one sweeps over them with the telescope gradually drawing toward the nucleus, have often reminded me of the approaches to such a city as London. Thicker and closer the twinkling points become, until at last, as the observer's eye follows the gorgeous lines of stars trending inward, he seems to be entering the streets of a brilliantly lighted metropolis.

Other objects in Gemini that we can ill miss are: μ, double, magnitudes three and eleven, distance 73″, p. 76°, colors yellow and blue; 15, double, magnitudes six and eight, distance 33″, p. 205°; γ, remarkable for array of small stars near it; 38, double, magnitudes six and eight, distance 6·5″, p. 162°, colors yellow and blue (very pretty); λ, double, magnitudes four and eleven, distance 10″, p. 30°, color of larger star blue—try with the five-inch; ϵ, double, magnitudes three and nine, distance 110″, p. 94°.

From Gemini we pass to Cancer. This constellation has no large stars, but its great cluster Præsepe (1681 on map No. 4) is easily seen as a starry cloud with the naked eye. With the telescope it presents the most brilliant appearance with a very low power. It was one of the first objects that Galileo turned to when he had completed his telescope, and he wonderingly counted its stars, of which he enumerated thirty-six, and made a diagram showing their positions.

The most interesting star in Cancer is ζ, a celebrated triple. The magnitudes of its components are six, seven, and seven and a half; distances 1″, p. 35°, and 5·5″, p. 122°. We must use our five-inch glass in order satisfactorily to separate the two nearest stars. The gravitational relationship of the three stars is very peculiar.

The nearest pair revolve around their common center in about fifty-eight years, while the third star revolves with the other two, around a center common to all three, in a period of six or seven hundred years. But the movements of the third star are erratic, and inexplicable except upon the hypothesis advanced by Seeliger, that there is an invisible, or dark, star near it by whose attraction its motion is perturbed.

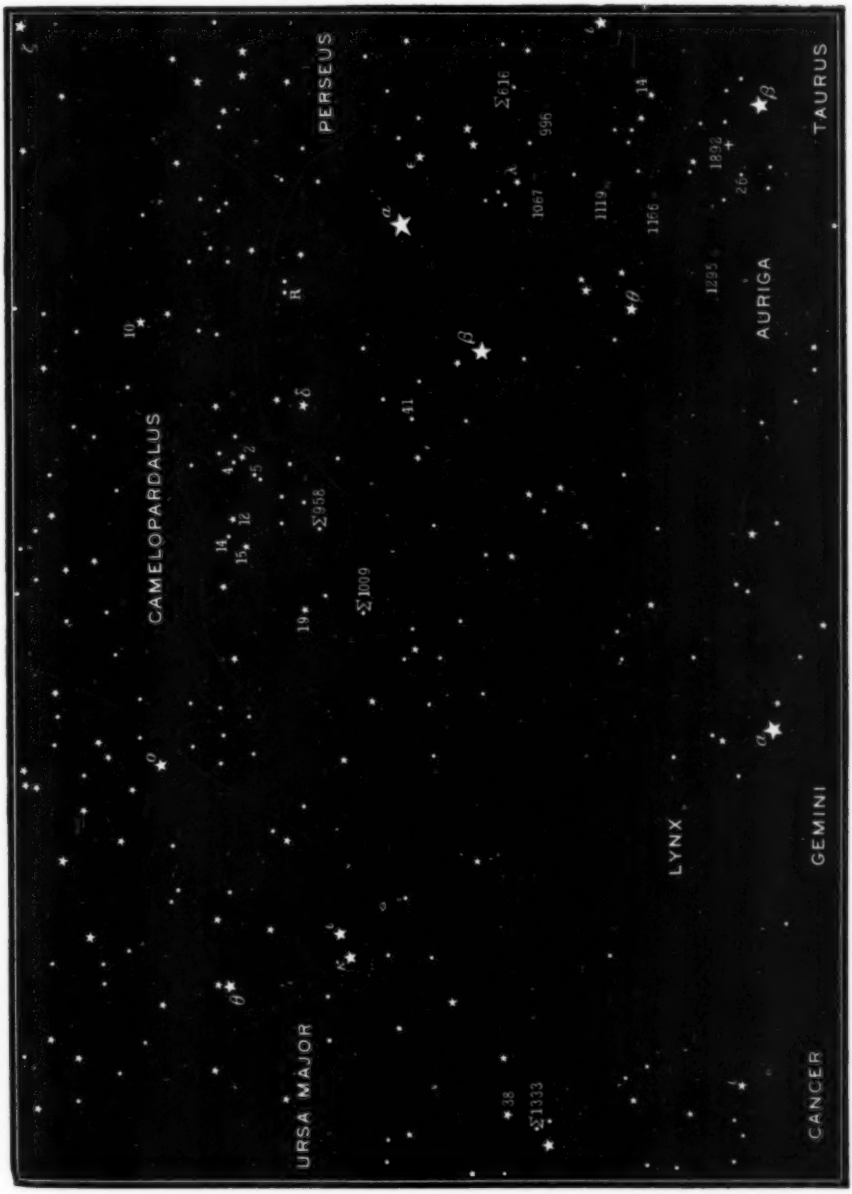
In endeavoring to picture the condition of things in ζ Cancri we might imagine our sun to have a companion sun, a half or a third as large as itself, and situated within what may be called planetary distance, circling with it around their center of gravity; while a third sun, smaller than the second and several times as far away, and accompanied by a *black* or non-luminous orb, swung with the first two around another center of motion. There you would have an entertaining complication for the inhabitants of a system of planets!

Other objects in Cancer are: Σ 1223, double star, magnitudes six and six and a half, distance 5″, p. 214°; Σ 1291, double, magnitudes both six, distance 1·3″, p. 328°—four-inch should split it; ι, double, magnitudes four and a half and six and a half, distance 30″, p. 308°; 66, double, magnitudes six and nine, distance 4·8″, p. 136°; Σ 1311, double, magnitudes both about the seventh, distance 7″, p. 200°; 1712, star cluster, very beautiful with the five-inch glass.

The constellation of Auriga may next command our attention (map No. 5). The calm beauty of its leading star Capella awakens an admiration that is not diminished by the rivalry of Orion's brilliants glittering to the south of it. Although Capella must be an enormously greater sun than ours, its spectrum bears so much resemblance to the solar spectrum that a further likeness of condition is suggested. No close companion to Capella has been discovered, and it is not probable that any exists except, possibly, in the form of planets which no telescope can reveal. A ninth-magnitude companion, distant 159″, p. 146°, and two others, one of twelfth magnitude at 78″, p. 317°, and the other of thirteenth magnitude at 126″, p. 183°, may be distant satellites of the great star, but not planets in the ordinary sense, since it is evident that they are self-luminous. It is as ignificant fact that most of the first-magnitude stars have faint companions which are not so distant as altogether to preclude the idea of physical relationship.

While we are in Auriga we must look at the star β (Menkalina), which belongs to a peculiar order of double stars discovered within the past few years. But neither our telescopes, nor any telescope in existence, can directly reveal the duplicity of β Aurigæ to the eye—i. e., we can not see the two stars composing it,

because they are so close that their light remains inextricably mingled after the highest practicable magnifying power has been applied in the effort to separate them. But the spectroscope



MAP No. 5.

shows that the star is double and that its components are in rapid revolution around one another, completing their orbital swing in the astonishingly short period of *four days!* The combined mass of the two stars is estimated to be two and a half times the mass

of the sun, and the distance between them, from center to center, is about eight million miles.

The manner in which the spectroscope revealed the existence of two stars in β Aurigæ is a beautiful illustration of the unexpected and, so to speak, automatic application of an old principle in the discovery of new facts not looked for. It was noticed at the Harvard Observatory that the lines in the photographed spectrum of β Aurigæ (and of a few other stars to be mentioned later) appeared single in some of the photographs and double in others. Investigation proved that the lines were doubled at regular intervals of about two days, and that they appeared single in the interim. The explanation was not far to seek. It is known that all stars which are approaching us have their spectral lines shifted, by virtue of their motion of approach, toward the violet end of the spectrum, and that, for a similar reason, all stars which are receding have their lines shifted toward the red end of the spectrum. Now, suppose two stars to be revolving around one another in a plane horizontal, or nearly so, to the line of sight. When they are at their greatest angular distance apart as seen from the earth one of them will evidently be approaching at the same moment that the other is receding. The spectral lines of the first will therefore be shifted toward the violet, and those of the second will be shifted toward the red. Then if the stars, when at their greatest distance apart, are still so close that the telescope can not separate them, their light will be combined in the spectrum; but the spectral lines, being simultaneously shifted in opposite directions, will necessarily appear to be doubled. As the revolution of the stars continues, however, it is clear that their motion will soon cease to be performed in the line of sight, and will become more and more athwart that line, and as this occurs the spectral lines will gradually assume their normal position and appear single. This is the sequence of phenomena in β Aurigæ.

Such facts, like those connecting rows and groups of stars with masses and spiral lines of nebula, present a terrible temptation to speculation; but who shall say that they do not also, like obscure signboards, indicate the opening of a way which, starting in an unexpected direction, nevertheless leads deep into the mysteries of the universe?

Southward from β we find the star θ, which is a beautiful quadruple. We shall do best with our five-inch here, although in a fine condition of the atmosphere the four-inch might suffice. The primary is of the third magnitude; the first companion is of magnitude seven and a half, distance 2″, p. 5°; the second, of the tenth magnitude, distance 45″, p. 292°; and the third, of the tenth magnitude, distance 125″, p. 350°.

We should look at the double Σ 616 with one of our larger

apertures in order to determine for ourselves what the colors of the components are. There is considerable diversity of opinion on this point. Some say the larger star is pale red and the smaller light blue; others consider the color of the larger star to be greenish, and some have even called it white. The magnitudes are five and nine, distance 6″, p. 350°.

Auriga contains several noteworthy clusters which will be found on the map. The most beautiful of these is 1295, in which about five hundred stars have been counted.

The position of the new star of 1892, known as Nova Aurigæ, is also indicated on the map. While this never made a brilliant appearance, it has given rise to a greater variety of speculative theories than any previous phenomenon of the kind. Although not recognized until January 24, 1892, this star, as photographic records prove, made its appearance about December 9, 1891. At its brightest it barely exceeded magnitude four and a half, and its maximum occurred within ten days after its first appearance. When discovered it was of the fifth magnitude. It was last seen in its original form with the Lick telescope on April 26th, when it had sunk to the lowest limit of visibility. To everybody's astonishment it reappeared in the following August, and on the 17th of that month was seen shining with the light of a tenth-magnitude star, *but presenting the spectrum of a nebula!* Its visual appearance in the great telescope was now also that of a planetary nebula. Its spectrum during the first period of its visibility had been carefully studied, so that the means existed for making a spectroscopic comparison of the phenomenon in its two phases. During the first period, when only a stellar spectrum was noticed, remarkable shiftings of the spectral lines occurred, indicating that two and perhaps three bodies were concerned in the production of the light of the new star, one of which was approaching the earth, while the other or the others receded, with velocities of several hundred miles per second! On the revival in the form of a planetary nebula, while the character of the spectrum had entirely changed, evidences of rapid motion in the line of sight remained. The nebulous speck which represents all that is left of Nova Aurigæ has not yet (February, 1895) faded from sight.

But what was the meaning of all this? Evidently a catastrophe of some kind had occurred out there in space. The idea of a collision involving the transformation of the energy of motion into that of light and heat suggests itself at once. But what were the circumstances of the collision? Did an extinguished sun, flying blindly through space, plunge into a vast cloud of meteoritic particles, and, under the lashing impact of so many myriads of missiles, break into superficial incandescence, while

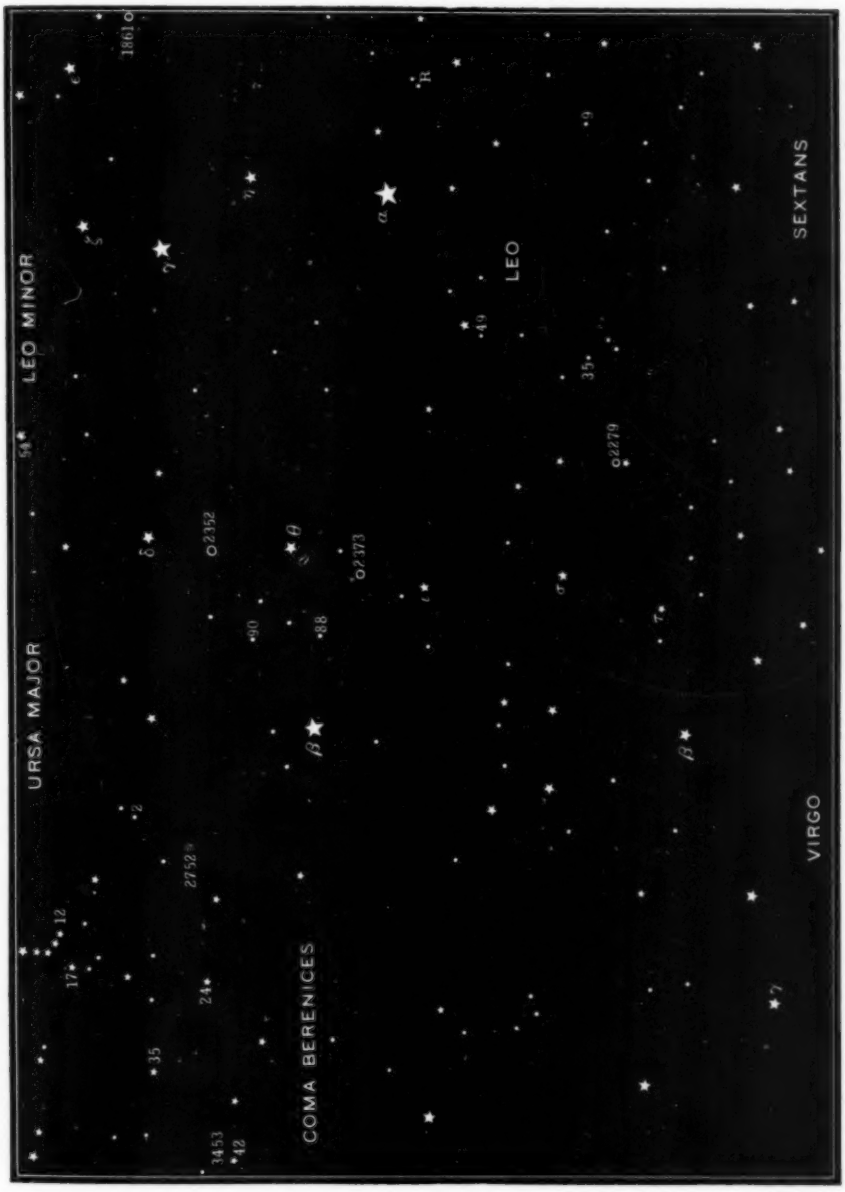
the cosmical wrack through which it had driven remained glowing with nebulous luminosity? Such an explanation has been offered by Seeliger. Or was Vogel right when he suggested that Nova Aurigæ could be accounted for by supposing that a wandering dark body had run into collision with a system of planets surrounding a decrepit sun (and therefore it is to be hoped uninhabited), and that those planets had been reduced to vapor and sent spinning by the encounter, the second outburst of light being caused by an outlying planet of the system falling a prey to the vagabond destroyer? Or some may prefer the explanation, based on a theory of Wilsing's, that *two* great bodies, partially or wholly opaque and nonluminous at their surfaces, but liquid hot within, approached one another so closely that the tremendous strain of their tidal attraction burst their shells asunder so that their bowels of fire gushed briefly visible, amid a blaze of spouting vapors. And yet Lockyer thinks that there was no solid or semi-solid mass concerned in the phenomenon at all, but that what occurred was simply the clash of two immense swarms of meteors that had crossed one another's track.

Well, where nobody positively knows, everybody has free choice. In the meantime, look at the spot in the sky where that little star made its appearance and underwent its marvelous transformation, for, even if you can see no remains of it there, you will feel your interest in the problem it has presented, and in the whole subject of astronomy, greatly heightened and vivified, as the visitor to the field of Waterloo becomes a lover of history on the spot.

The remaining objects of special interest in Auriga may be briefly mentioned: 26, triple star, magnitudes five, eight, and eleven, distances 12″, p. 268°, and 26″, p. 113°; 14, triple star, magnitudes five, seven and a half, and eleven, distances 14″, p. 224°, and 12·6″, p. 342°, the last difficult for moderate apertures; λ, double, magnitudes five and nine, distance 121″, p. 13°; ϵ, variable, generally of third magnitude, but has been seen of only four and a half magnitude; 41, double, magnitudes five and six, distance 8″, p. 354°; 996, 1067, 1119, and 1166, clusters all well worth inspection, 1119 being especially beautiful.

The inconspicuous Lynx furnishes some fine telescopic objects, all grouped near the northwestern corner of the constellation. Without a six-inch telescope it would be a waste of time to attack the double star 4, whose components are of sixth and eighth magnitudes, distance 0·8″, p. 103°; but its neighbor, 5, a fine triple, is within our reach, the magnitudes being six, ten, and eight, distances 30″, p. 139°, and 96″, p. 272°. In 12 Lyncis we find one of the most attractive of triple stars, which in good seeing weather is not beyond the powers of a three-inch glass, although we shall

have a far more satisfactory view of it with the four-inch. The components are of the sixth, seventh, and eighth magnitudes, distances 1·5″, p. 122°, and 8·7″, p. 304°. A magnifying power which



Map No. 6.

just suffices clearly to separate the disks of the two nearer stars makes this a fine sight. A beautiful contrast of colors belongs to the double star 14, but unfortunately the star is at present very close, the distance between its sixth and seventh magnitude com-

ponents not exceeding 0·8″, position angle 64°. Σ 958 is a pretty double, both stars being of the sixth magnitude, distance 5″, p. 257°. Still finer is Σ 1009, a double, whose stars are both a little above the seventh magnitude and nearly equal, distance 3″, p. 156°. A low power suffices to show the three stars in 19, their magnitudes being six and a half, seven and a half, and eight, distances 15″, p. 312°, and 215″, p. 358°. Webb describes the two smaller stars as plum-colored. Plum-colored suns?

At the opposite end of the constellation are two fine doubles, Σ 1333, magnitudes six and a half and seven, distance 1·4″, p. 39°; and 38, magnitudes four and seven, distance 2·9″, p. 235°.

Under the guidance of map No. 6 we turn to Leo, which contains one of the leading gems among the double stars, γ, whose components, of third and fourth magnitudes, are respectively yellow and green, the green star, according to some observers, having a peculiar tinge of red. Their distance apart is 3·5″, p. 114°, and they are undoubtedly in revolution about a common center, the probable period being about four hundred years. The three-inch glass should separate them easily when the air is steady, and a pleasing sight they are.

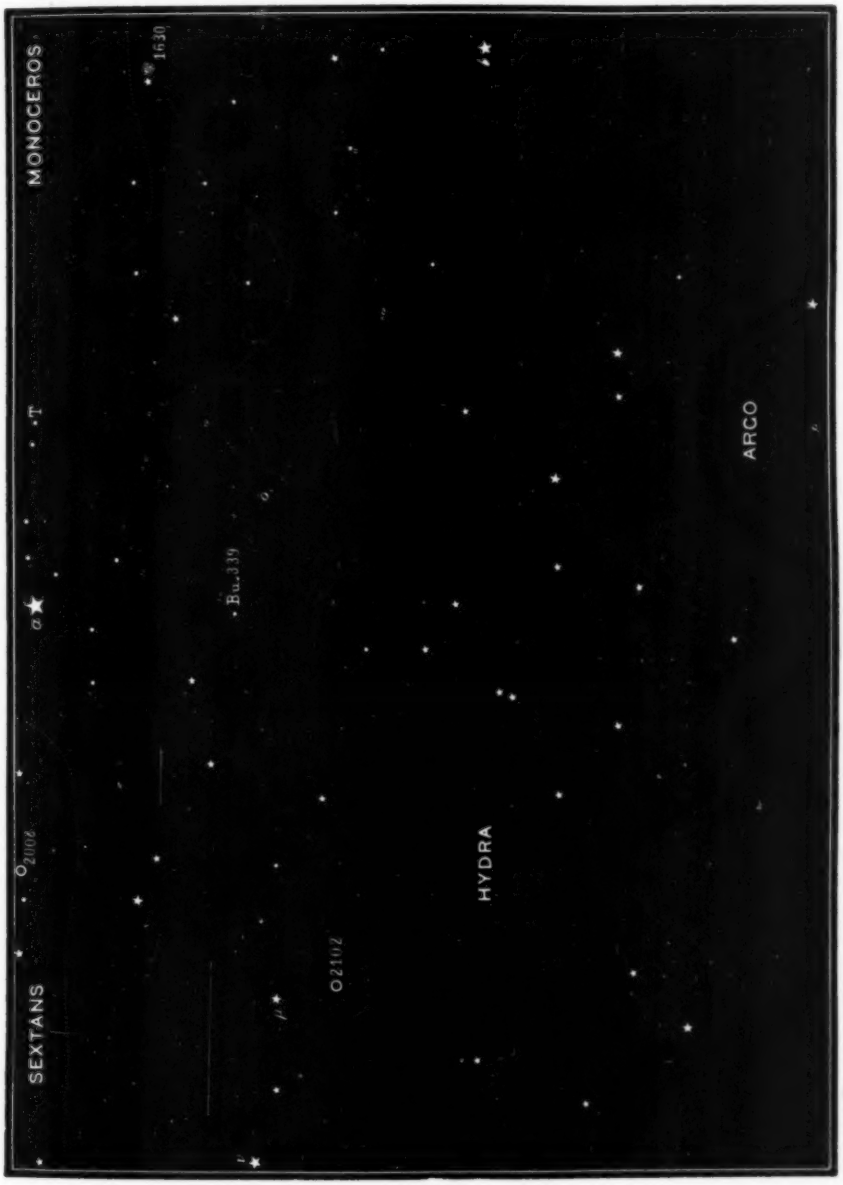
The star ι is a closer double, and also very pretty, magnitudes four and eight, colors lemon and light blue, distance 2·7″, p. 65°. Other doubles are τ, magnitudes five and seven, distance 95″, p. 170°; 88, magnitudes seven and nine, distance 15″, p. 320°; 90, triple, magnitudes six, seven and a half, and ten, distance 3·5″, p. 209°, and 59″, p. 234°; 54, magnitudes four and a half and seven, distance 6·2″, p. 102°; and 49, magnitudes six and nine, distance 2·4″, p. 158°.

Leo contains a remarkable variable star, R, deep red in color, and varying in a space of a hundred and forty-four days from the fifth to the tenth magnitude. It has also several nebulæ, of which only one needs special mention, No. 1861. This is spindle-shaped, and large telescopes show that it consists of three nebulæ. The observer with ordinary instruments finds little to see and little to interest him in these small, faint nebulæ.

We may just glance at two double stars in the small constellation of Sextans, situated under Leo. These are: 9, magnitudes seven and eight, distance 53″, p. 292°; and 35, magnitudes six and seven, distance 6·9″, p. 240°.

Coma Berenices (map No. 6) contains several interesting objects. Let us begin with the star 2, a double, of magnitudes six and seven and a half, distance 3·6″, p. 240°. The color of the smaller star is lilac. This hue, although not extremely uncommon among double stars elsewhere, recurs again and again, with singular persistence, in this little constellation. For instance, in the very next star that we look at, 12, we find a double whose

smaller component is *lilac*. The magnitudes in 12 are five and eight, distance 66″, p. 168°. So also the wide double 17, magnitudes five and a half and six, distance 145″, exhibits a tinge of *lilac* in the



MAP No. 7.

smaller component; the triple 35, magnitudes five, eight, and nine, distances 1·3″, p. 61°, and 28·7″, p. 124°, has for colors yellow, *lilac*, and blue, and the double 24, magnitudes five and six, distance 20″, p. 270°, combines an orange with a *lilac* star, a very striking and

beautiful contrast. We should make a sad mistake if we regarded this wonderful distribution of color among the double stars as accidental. It is manifestly expressive of their physical condition, although we can not yet decipher its exact meaning.

The binary 42 Comæ Berenicis is too close for ordinary telescopes, but it is highly interesting as an intermediate between those pairs which the telescope is able to separate and those—like β Aurigæ—which no magnifying power can divide, but which reveal the fact that they are double by the periodical splitting of their spectral lines. The orbit in 42 Comæ Berenicis is a very small one, so that even when the components are at their greatest distance apart they can not be separated by a five or six inch glass. Burnham, using the Lick telescope, in 1890 made the distance 0·7″; Hall, using the Washington telescope, in 1891 made it a trifle more than 0·5″. He had measured it in 1886 as only 0·27″. The period of revolution is believed to be about twenty-five years.

In Coma Berenices there is an outlying field of the wonderful nebulous region of Virgo, which we may explore on some future evening. But the nebulæ in Coma are very faint, and, for an amateur, hardly worth the trouble required to pick them up. The two clusters included in the map, 2752 and 3453, are bright enough to repay inspection with our largest aperture.

Although Hydra is the largest constellation in the heavens, extending about seven hours, or 105°, in right ascension, it contains comparatively few objects of interest, and most of these are in the head or western end of the constellation, which we examined during our first night at the telescope. In the central portion of Hydra, represented on map No. 7, we find its leading star α, sometimes called Alphard, or Cor Hydræ, a bright second-magnitude star that has been suspected of variability. It has a decided orange tint, and is accompanied, at a distance of 281″, p. 153°, by a greenish tenth-magnitude star. Bu. 339 is a fine double, magnitudes eight and nine and a half, distance 1·3″, p. 216°. The planetary nebula 2102 is about 1′ in diameter, pale blue in color, and worth looking at, because it is brighter than most objects of its class. Tempel and Secchi have given wonderful descriptions of it, both finding multitudes of stars intermingled with nebulous matter.

For a last glimpse at celestial splendors for the night, let us turn to the rich cluster 1630, in Argo, just above the place where the stream of the Milky Way—here bright in mid-channel and shallowing toward the shores—separates into two or three currents before disappearing behind the horizon. It is by no means as brilliant as some of the star clusters we have seen, but it gains in beauty and impressiveness from the presence of one bright star that seems to captain a host of inferior luminaries.

THE UNITED STATES GEOLOGICAL SURVEY.*

By CHARLES D. WALCOTT,
DIRECTOR OF THE SURVEY.

GEOLOGY in America has advanced by steady evolution from a small beginning eighty years ago to its present proportions, where it stands as one of the great sciences of the present and of the future. The geologists of Europe founded the science of geology in the earlier years of this century, and as the tide of emigration passed across to this continent it brought with it a knowledge of science and a spirit of scientific investigation. In geology this first took systematic form in the State of New York. State after State then took up the work, and finally the Federal Government, in its western Territories. Among the men who have led in the States were William Maclure, Amos Eaton, James Hall, Ebenezer Emmons, Timothy Conrad, and their associates on the New York Survey; the brothers Rogers, and Richard Dale Owen. Jules Marcou, J. S. Newberry, and others began work in the west under the Federal Government, and following them the organizers of the first Government surveys—Clarence King, F. V. Hayden, J. W. Powell, and George M. Wheeler.

The organization of the present Geological Survey went into effect July 1, 1879, the independent surveys that had previously existed having been discontinued. It is a bureau of the Department of the Interior, and is under the immediate control of a director, who is appointed by the President and confirmed by the Senate. The members of the regular and permanent corps of the survey are nominated by the director and appointed by the Secretary of the Interior, the director making only such temporary appointments as are authorized by the secretary. A plan of operations and an estimate of the expenses of the survey are submitted annually to the secretary, to whom the director also makes report of the operations of the survey at the close of each fiscal year.

The survey occupies a rented building which has 46,480 square feet of floor space. In addition, the engraving and printing division occupies an annex building, with 8,253 square feet of floor space, and in the National Museum there are four laboratories for the preparation and study of paleontologic and paleobotanic material. Within the main building there is a chemical laboratory, in which analyses of rocks, oils, minerals, etc., are made for the geologists of the survey, as well as certain special investigations

* Presidential Address before the Geological Society of Washington, delivered December 18, 1894.

relating to problems directly affecting the study of rocks or minerals, a knowledge of which is necessary for the field geologist; a photographic laboratory, in which all negatives taken in the field are developed and prints made therefrom, and where the field topographic maps are reduced to the scale required before engraving for publication; a petrographic laboratory, which includes the necessary machinery for cutting thin sections of rocks and minerals, and for the cutting and polishing of sections of limestones, fossils, etc.

The topographic division occupies the fourth and fifth floors of the main building. This division is fully equipped with the necessary instruments for triangulation and topographic surveying. The second and third floors are occupied by the geologists of the survey, and the first floor by the administrative offices, the editorial rooms, and the library. The library at the present time contains thirty-five thousand books, fifty thousand pamphlets, and twenty-six thousand maps, all of which are intended for study and reference by the members of the survey. The administrative branch of the survey includes the chief clerk's office, the financial division, and the miscellaneous or correspondence division. In the printing division there is a full equipment for engraving, lithographing, and printing the topographic maps and folios of the survey.

The organic law of the survey, enacted in 1879, provides that "the director of the Geological Survey shall have the direction of the Geological Survey and the classification of the public lands and examination of the geological structure and mineral resources and products of the national domain." In 1882 the doubt as to the territory to be embraced by the operations of the survey was removed by the addition of the words "and to continue the preparation of a geological map of the United States." Under the directorship of Mr. Clarence King prominence was given to investigations of the mineral resources of the Rocky Mountain region in Colorado, Utah, and Nevada. A general division of mining geology was also organized, but, owing to the uncertainty of the area to be included under the term "national domain," its operations were limited to the States and Territories of the west. With the change of directorship in 1881 and the granting of authority in 1882 to complete a geological map of the United States, the policy of the survey was modified and its work was directed, under a very comprehensive plan, to the preparation of the required geologic map. This included the making of a topographic map of the entire United States as a base for the mapping of the areal geology. As adequate maps were not in existence, and areal geology without a good topographic base would be of little value, the topographic work was pushed forward; and in geology spe-

cial attention was given to the consideration and solution of certain broad geologic problems presented by the wide domain of the United States. These problems embraced those of the geologic growth and development of a great continent, many of which had to be solved before the areal geographic mapping could be carried forward intelligently and with due consideration for scientific accuracy and economy. With the completion of topographic sheets, areal geology was gradually taken up, and in 1894 more than three fourths of the available geologic force was employed in areal work.

The scope of the work of the Geological Survey has thus come to include the preparation of a topographic base map of the entire United States; the study and mapping of the areal geology upon this base; the examination of the geologic structure and mineral resources of the national domain; the gathering of the statistics of mineral production; the study of the artesian and surface water supply of the United States; and, indirectly, the mineral and agricultural classification of the public lands under survey.

There is one fact that should be borne in mind when considering the scope of the work, and that is that the Geological Survey is a bureau of research. Its work is to a large extent the discovery of unknown facts and principles, and the scientific co-ordination of these and all known facts and inductions, within the scope of its work, in such a form that they shall subserve the use of both the Government and the people; the latter to include not only the farmer, prospector, miner, owner of lands, investor, and mining and civil engineer, but also the most highly trained students, teachers, and specialists.

TOPOGRAPHIC BASE MAP.—Captain George M. Wheeler said of topographic surveys: "The topographic is the indispensable, all-important survey, being general and not special in its character, which underlies every other, including also the graphic basis of the economic and scientific examinations of the country. . . . This has been the main or principal general survey in all civilized countries, and all other so-called surveys (as geodetic, trigonometric, etc.) are but accessories or addenda thereto. . . . The results of such a survey become the mother source whence all other physical examinations may draw their graphic sustenance." *

A recent European writer † (1892) on the general topographic maps of the present time says that all European states have undertaken uniform and continuous topographic surveys of their

* Facts regarding the Origin, Organization, etc., of Government Land and Marine Surveys of the United States. 1885. 4to pamphlet. Washington, D. C.: War Department.

† C. Lowinsin Ymer. Tidskrift utgiven af Svenska Sallskapet for Antropologi och Geografi. 1891. Elfte argangen, 3e och 4e haft (slut). Stockholm: Samson & Wallin, 1892.

whole domains, and that outside of Europe the United States claim first attention by their grand topographic works.

Similar surveys are also in progress in the principal colonies of the European powers, such as India, Canada, Algeria, Tunis, etc. The scale of the maps varies from 1 : 2,000 to 1 : 420,000.

According to Lowinsin, seventy per cent of the area of Europe has had a fairly satisfactory topographic survey; and of the land area of the world, about twenty-seven per cent has been surveyed more or less accurately. Bartholomew estimates that only one seventh of the whole land surface of the globe has been exactly surveyed. He publishes an instructive map exhibiting the area of topographic surveys, both exact and general, and of geographic surveys, both fairly reliable and approximate or hypothetical.*

Most European topographic maps were made, primarily, for military purposes, under the supervision of military officers, and secondarily for the scientist and statesman only. In the United States the necessities of the geologist developed the first interior surveys, and they are now being carried forward under the direction of the Geological Survey, and, along the ocean borders, by the Coast and Goedetic Survey.

The methods employed are the same in all topographic surveys, in respect to the two essential divisions of work, viz., location of points of control and sketching in of contours, streams, culture, etc. The minor methods of procedure differ in details within these two divisions; but geometrically located points of control are in all cases obtained, and the contours, roads, streams, and all features shown on the map are sketched in, whether the located points of control are ten inches or a thousand feet apart. Usually it is only the features sketched that appear on the map, as the geometrically located points that control the sketch are mathematical points. If desired they can be represented by conventional signs.

The first contoured topographic maps of the United States for geologic purposes were on the scale of 1 : 250,000 (four miles to the inch), with contour intervals of two hundred to two hundred and fifty feet; but the necessities of science and the demands of the public called for a more detailed map, and the scale of 1 : 125,000 (two miles to the inch) was adopted. This was again enlarged in certain regions to 1 : 62,500 (one mile to the inch). The topographic maps of the Geological Survey are now being made, in the rougher mountain region and thinly populated areas, on the 1 : 125,000 scale, with contour intervals of from ten to one hundred feet, and in the more valuable, economic, and thickly populated areas, on the 1 : 62,500 scale, with contour intervals of from five to one hundred

* John George Bartholomew. Scottish Geographical Magazine, vol. vi, 1890, pp. 294, 295, and map.

feet. Special maps, for the detailed survey of areas of unusual mining or scientific interest, are made on still larger scales, up to 1 : 10,000. With the increase in scale there has been an increase in cost; but the latter has been in a considerably smaller ratio than the increase in the value of the maps produced. Since the beginning of topographic surveys by the Geological Survey there has been a steady improvement of methods, and the survey has been making better maps during the past two years than ever before.

Primarily the topographic maps are for the use of the geologist, and their scale has been determined largely by this fact. With the progress of the survey from year to year, the public became more and more acquainted with the maps, and a strong demand arose for the topographic maps as such. Massachusetts, Rhode Island, Connecticut, and New York asked to have the work pushed more rapidly within their respective boundaries; this was done on the condition that the State pay one half of the cost of the work. Of the States mentioned, all have a completed topographic map with the exception of New York. In the great semi-arid region of the interior the maps were requested as an aid in the development of their resources in artesian water and in the application of drainage waters to irrigation. Severe criticism of the survey has been made on account of the extent of the topographic surveys in the semi-arid region; but when it is considered that the Geological Survey is a national institution, it is evident that the great interior has as just a claim for consideration as the mining regions of the mountain areas of the eastern and western sides of the continent. If water is the principal mineral resource, it should receive due attention in making the topographic map. The uses of the topographic maps are many, and it is the policy of the survey to give them as high a standard of accuracy as the limit of scale will permit. A map may cost one dollar or one thousand dollars, or more, a square mile, according to its scale and its contents. For general purposes an excellent map can be made for ten dollars a square mile, one that will subserve the uses of the geologist and the people. This will answer for nine tenths or more of the area of the country; and when more detailed, expensive maps are required for the remaining tenth, they can and will be made. In the meantime the development of the country will be assisted in many ways by the maps constructed on the scales now adopted.

The following table exhibits the area of topographic work completed up to December 1, 1894. Of this, a considerable portion of the 1 : 250,000 scale (four miles to the inch) will be revised as detailed geologic work is carried forward. A thorough revision will also need to be made of certain areas in the Appalachian Mountains and west of the Mississippi River, to the Pacific.

This arises mainly from defective work in the earlier years of the survey, when men and methods were more or less on trial, and from the demand for more detailed and accurate maps on which to plat the geology of the coal and iron regions of the Appalachians, and the gold, silver, iron, coal, and artesian areas of other sections of the country:

	Area surveyed, sq. miles.	SCALES.			Per cent of total area surveyed.
		1/62,500	1/125,000	1/250,000	
Alabama	15,870	.....	15,870	.....	30
Arizona	41,000	.....	.....	41,000	36
Arkansas	15,000	.....	15,000	.....	28
California	35,100	4,000	16,700	14,400	22
Colorado	36,000	1,500	34,500	.....	35
Connecticut	4,990	4,990	.....	.....	100
Delaware	15	15	.....	.....	1
District of Columbia	70	70	.....	.....	100
Florida	1,900	1,900	.....	.....	3
Georgia	15,275	.....	15,275	.....	26
Idaho	12,000	.....	12,000	.....	14
Illinois	3,875	3,875	.....	.....	7
Indiana	20	20	.....	.....	..
Indian Territory	250	.....	250	.....	1
Iowa	4,450	4,450	.....	.....	8
Kentucky	12,800	.....	12,800	.....	32
Kansas	67,385	.....	67,385	.....	82
Louisiana	7,000	7,000	.....	.....	14
Maine	4,200	4,200	.....	.....	13
Maryland	6,930	3,000	3,930	.....	57
Massachusetts	8,315	8,315	.....	.....	100
Michigan	231	231	.....	.....	..
Minnesota	850	850	.....	.....	1
Missouri	26,000	300	25,700	.....	37
Montana	14,400	.....	6,000	8,400	10
Nebraska	14,300	.....	14,300	.....	18
Nevada	19,980	.....	5,580	14,400	18
New Hampshire	1,990	1,990	.....	.....	21
New Jersey	7,815	7,815	.....	.....	100
New Mexico	27,800	.....	10,000	17,800	23
New York	10,000	10,000	.....	.....	20
North Carolina	11,110	.....	11,110	.....	21
North Dakota	4,960	.....	4,960	.....	7
Ohio	50	.....	50	.....	..
Oklahoma Territory	3,423	.....	.....	.....	9
Oregon	13,180	.....	980	12,200	14
Pennsylvania	6,537	6,537	.....	.....	14
Rhode Island	1,250	1,250	.. ...	.....	100
South Carolina	4,350	.....	4,350	.....	14
South Dakota	9,800	.....	9,800	.....	13
Tennessee	19,000	.....	19,000	.....	45
Texas	57,000	.....	57,000	.....	21
Utah	6,000	.....	.....	6,000	7
Vermont	2,175	2,175	.....	.....	23
Virginia	32,120	1,120	31,000	.....	84
Washington	450	450	.....	.....	1
West Virginia	22,500	.....	22,500	.....	90
Wisconsin	6,540	6,540	.....	.....	12
Wyoming	7,700	.....	7,700	.....	8
	624,016	94,793	427,163	102,060	
Per cent of all	.....	15	68	17	

In addition to the above, areas amounting to about one hundred and six thousand square miles have been adopted from the Powell, Wheeler, Hayden, and King surveys, and published on the scale of 1:250,000. From this table it appears that during the past twelve years the Geological Survey has mapped six hundred and twenty-four thousand square miles, being more than one fifth the area of the country, excluding Alaska. Of this, more than two thirds is on the scale of 1:125,000, and nearly one sixth on the scale of 1:62,500.

GEOLOGIC WORK.—The geologic work is readily classified as *special investigations* and *areal mapping.*

The first branch of the geologic work, special investigations, is illustrated by the study and report on The Tertiary History of the Grand Cañon District, by Captain C. E. Dutton; Lake Bonneville, by Mr. G. K. Gilbert; Geology and Mining Industry of Leadville, Colorado, by Prof. S. F. Emmons; The Palæozoic Fishes of North America, by Prof. J. S. Newberry; and the thorough investigation of the geologic phenomena of the Yellowstone National Park, by Mr. Arnold Hague. Twenty-four monographs and one hundred and sixteen bulletins have been published by the survey as the results of such investigations. They are frequently the basis of generalizations that must be obtained before the areal geologic work can be successfully prosecuted; and the areal geologist is constantly making use of the data furnished him by the specialist. Immense collections have been accumulated in the laboratories of the survey and in the National Museum, which are the basis of correlations used almost constantly in areal mapping and frequently in the solution of problems arising in connection with the study of economic questions of a high order. The interrelation of the various branches of geology are such that all must be kept up to a high standard, or all will sooner or later deteriorate and thus affect the quality of the output of results by the survey.

Under the direction given, in 1882, to complete the geological map of the United States, a comprehensive scheme of work was outlined. A large corps of geologists soon began work on various problems that arose in planning a system of mapping that would serve for all phases of geology to be met with in the three million square miles of the area of the United States. A large amount of valuable detailed local work had been done by various State surveys; several of the Government surveys had made more or less complete reconnaissances of large areas west of the Mississippi River, and a few fairly accurate geologic maps were published by them; but the State and Government surveys had been conducted each in its own way and with little regard to co-ordination with the work of the others. It was necessary to bind

together the scattered results of all these in a comprehensive whole, before a beginning could be made on the publication of the geologic map. This work was carried forward for ten years before the first folio of the final geologic map was published. Most of the larger questions affecting the classification and nomenclature of the sedimentary and volcanic rocks were brought to a satisfactory conclusion. Great progress was made in the study of the altered (metamorphic) rocks and of the complex of crystalline rocks grouped under the term "Archean." A satisfactory solution of the lower Mesozoic (Juratrias) series is yet to be reached; and there is a great field in the pre-Paleozoic sedimentary and crystalline formations, in which further study will bring out important data for classification and geologic mapping; but the areas affected are relatively small within the United States, and the areal geologic mapping can go on without serious injury on this account. Director Powell and members of the survey gave much time and thought as to the best method of representing the geology on maps. The result is a color scheme that, under the skillful application of the editor of geologic maps, has thus far met the demands made upon it.

The areal geologic map in its final form, as presented in the geologic folios, is intended to place before the geologist, mining engineer, student, and all persons interested the topography and geology of the area included within each atlas sheet. The topographic map has already been mentioned. In each folio a brief explanation is printed of the topographic and geologic maps and of the uses to which they can be applied. It is a simple, short lesson for the layman, to enable him to make use of the folios intelligently.

The areal geologic map represents all that the geologist preparing it knows of the areal distribution of the rocks occurring within its area, so far as he can delineate such knowledge within the scale of the map. Taken in connection with the topographic base, it presents the geologic distribution of the various rocks in a form for the use of geologists and students, but it does not appeal directly to persons interested in the mineral resources of the region. To meet this important demand a second map is prepared, upon which the rocks carrying minerals of economic value are clearly indicated by distinct colors, the import of which is shown by the colored legend on the margin of the map. Thus the distribution of the coal- and iron-bearing rocks of the Appalachians in Tennessee and other States, and of the gold-bearing rocks of California and elsewhere, is clearly presented. These maps refer only to the areal distribution of the rocks. What is known of the underground geology is graphically illustrated on a structure section sheet and a sheet of columnar sections. With

the four sheets before him the geologist, mining engineer, landowner, or other inquirer has in view in graphic form all that the geologist can tell him of the area. A general text accompanies the folio; and, when considered necessary, a full, detailed description will be published in the form of a bulletin. This is as far as the director of the survey considers that he is legally authorized to go in the preparation of a geologic map. On the scale now used this map will require many years for its completion. Its value depends upon its thoroughness, and it is thought that quality, up to the scale adopted, is to be considered before the question of area. The standard adopted is to do the field work up to and beyond the scale of the map, and to represent on the map all that the scale will permit. The result thus far is shown in the folios published, and the folios of the future will prove the quality of the work now being done. Cost and practical working methods limit the ideal perfection of field work and of the resulting maps; but in all cases the ideal standard will be aimed at, and the attempt made to present the best results obtainable under the conditions surrounding the work.

ECONOMIC WORK.—Some one has said that utility is the bane of science, and a greater man has written that Philosophy is never more exalted than when she stoops to minister to humanity. Geology is essentially practical in many of its branches, and thus commends itself to those interested in the material welfare of individuals, communities, and nations; and, at the same time, its great problems concerning the history of the evolution of the earth and of life, including man, command the attention of intelligent mankind. In its economic aspect the Geological Survey touches the interests of the people in many and varied ways. Human endeavor is limited to the surface of the earth and its immediate underground resources, and whatever is of assistance here is an aid in the development of the higher material civilization.

In the first place, good topographic maps are essential. They are needed in the construction of roads of all kinds, and in problems of water supply and drainage. In all future military operations such maps will be of service. As a basis for representing the distribution of mineral resources they can not be dispensed with, and in all investigations relating to the surface of the earth they are of great value.

Mineral Resources. The organic law of the survey provides that the director shall have charge of the examination of the mineral resources and products of the national domain. This has been interpreted to mean a *statistical* examination of the products from the mineral resources, and a *geologic* examination of their occurrence and character. The former has led to the compilation

of statistics and the publication of an annual volume under the title of Mineral Resources. It is proposed to continue this work, and to make it as complete and accurate as the means available will permit. It seems particularly appropriate that the Government should collect statistics of mineral production, and give the volume prompt publication and wide circulation. The first ten annual volumes have appeared as a distinct publication by the survey, but in the future it is proposed to issue the statistics as the second part of the annual report of the director.

Geologic Economic Work. The geologic examination of the mineral resources is one that commended itself very strongly to Mr. King. He regarded it as the primary work of the survey, and gave it great impetus by establishing surveys of the Leadville district of Colorado and of the Eureka and Virginia silver districts of Nevada. These were carried forward under Major Powell, and new economic work was entered upon. Dr. Becker surveyed and completed a report on the quicksilver deposits of California, and began a thorough survey of the gold belt of California. Profs. Irving and Van Hise surveyed and reported on the copper district of Lake Superior, and pushed forward researches on the iron-ore districts of Wisconsin and Michigan. The phosphate deposits of Florida were studied, and the mapping of the coal fields of the Appalachians was begun. With the development of areal geologic work, 1886 to 1891, many minor economic problems were met with and studied. Previous to 1892, when the appropriation for geology was reduced more than one half, a large percentage of it was employed in distinctly economic work. With the revival of geologic work the present year, the geologic examination of the mineral resources has received attention. A statement of what has been and is being done the present year will explain the present policy of the survey.

Four field parties were engaged in the areal survey of the coal fields of Tennessee, Virginia, West Virginia, and Maryland; one party on the iron-ore deposits of western North Carolina; one party on the marbles, etc., of northwestern Georgia; one party in making a preliminary study and reconnaissance of the gold belt of Georgia, South and North Carolina, and Virginia; one party on the southern limit of the roofing-slate belt of eastern New York; one large party on the iron ores of northern Wisconsin; one party on the mining districts of the Helena atlas sheet of Montana; one party on the Cripple Creek gold field, and in making a reconnaissance of the Rico district of Colorado; one party in completing the survey of the Leadville (Col.) district; one party in surveying the coal field of the Trinidad, El Moro, and Walsenburg sheets, Colorado; one party in studying the artesian water problem of the valley of the Arkansas, in Colorado and Kansas;

three parties in the study of the water supply of the United States, especially in the arid and semi-arid central region; one party in examining the clays, etc., in connection with the areal geology of central Texas; one party in making a reconnaissance of the mineral belt of central Idaho; and two parties in the areal mapping and a study of the gold belt of California. Thus twenty-one parties were engaged in work relating to important resources. It is also planned to continue the study of the phosphate deposits of Florida during the winter, and to begin the mapping of the coal deposits of southwest Oregon and western Washington in the spring of 1895. In addition, work on the geology of highways has been started, and the economic chemical work of the survey has been continued. To provide topographic maps for the geologic work thirty-two topographic field parties were engaged in the various sections of the country.

A typical illustration of geologic economic work is that on the iron-ore deposits of the Lake Superior region. The results include the determination of the geologic position and geographic distribution of the iron-bearing formations, and of the laws which control the occurrence of ore bodies within the iron-bearing formations.

First.—The investigations thus far made show the presence of an iron-bearing formation at the summit of the lower Huronian series, another near its base, and a third at the base of the upper Huronian series which was derived largely from the detritus of the iron-bearing formation of the lower Huronian. Their geographic distribution has been carefully mapped in the old districts and also in new districts, where prospecting had not yet shown them to exist.

Second.—The discovery of the laws which control the occurrence of the ore bodies is of equal if not of greater economic importance than the mapping of the iron-bearing formations. They are as follows: 1. The iron ores always rest upon a relatively impervious basement. 2. Large ore bodies are found only when the impervious basements are in the form of pitching troughs. 3. The pitching troughs are particularly likely to bear unusually large ore bodies when the iron-bearing formation has been much shattered by folding.

By the aid of the areal and structural maps which have been and will be prepared, and the application of the above laws, the mining engineer may avoid unnecessary expenditure of money in exploration, and be guided in the development of the mineral resources of the region.

Hydrography. The scope of the work of the hydrographic division of the survey is expressed in the statute authorizing it, which reads: "For gauging the streams and determining the

water supply of the United States, including the investigation of underground currents and artesian wells in arid and semi-arid regions. . . ." (Passed August 18, 1894.)

The demand on the survey from time to time for information concerning the water resources of the country has increased from year to year, especially from the arid and semi-arid regions of the west. Inquiries come from farmers seeking to provide water for domestic use and for irrigation, from individuals and from municipal organizations seeking artesian water supply and water power, and from members of Congress having in view legislation concerning the regulation of streams flowing across State or national boundaries. Response to the inquiries made requires not only broad knowledge of the topography, geologic structure, and meteorologic conditions of the regions involved, but also more or less familiarity with local conditions. In the past the hydrographic work of the survey has been limited because of the small sum available for the purpose. Such results as have been secured were largely an incidental product of the brief irrigation survey, which was practically suspended in 1891. Under the law above quoted, the work was taken up systematically during the present year, and will now be prosecuted as thoroughly and extensively as the money appropriated for the purpose will permit. A large amount of volunteer assistance has been given by local observers who realize the value of the work, and by railroad companies which are sufficiently interested to have their bridge-tenders read the river gauges. By this co-operation much more extensive results are possible than with the limited resources thus far at the command of the survey.

The water which has been utilized for irrigation by the farmers of the west is that which is most readily available, but both the great supply of storm water and the underground yield are scarcely touched. The utilization of this unappropriated water is the first condition for the further development of the arid and semi-arid lands in both public and private ownership. In order that the water may be intelligently utilized it is necessary that a thorough investigation should be made to obtain information as to the quantity and its fluctuations, before dams and reservoirs for storing it can be economically constructed.

The range of the requests for information on this point and concerning water powers shows the popular appreciation of the best work in this direction. From this standpoint the inquiries are encouraging; at the same time they are embarrassing, in that it is assumed that the survey has extended its investigation over the whole field. The data, however, are far from sufficient, and for their completion there is demand for a field survey which should be prosecuted at once and in the most thorough and sys-

tematic manner possible. The work is essentially economic, and, owing to its intimate relations to geology, is considered to be directly germane to the work of the survey.

Highways. The geology of highways embraces the study of the materials entering into their construction. It is distinct from the engineering problem of the mechanical construction of highways—a subject that is not intended to be taken up by the survey. The main questions have to do with the choice and manipulation of materials. Experience has shown that many kinds of rocks, which are not suitable for road-building when used alone, may be combined with other materials in such wise as to give good results. It is well known that in many districts great expense has been incurred in building roads on the best known engineering principles of road construction, with the result of producing dusty roads in summer and muddy roads in winter. This outcome is the result of ignorance in regard to the character of the rock necessary for the production of good roads. Inferior materials have sometimes been used when there were other materials in the immediate vicinity which alone or in combination would have produced a solid roadbed. A large part of the country, including the greater portion of the southern States and some portions of the Mississippi basin, has been thought to be essentially destitute of materials suitable for the construction of good roads. The inquiries that have been made by geologists have shown that in many places within these regions there are hidden deposits of gravel and other sorts of rocks which, when properly used, might give excellent highways; and that around the margin of this great area, often within the limits of convenient railway distribution, there are abundant supplies of rock well fitted for such use. It only remains to discover the supply of such rocks as are cheapest and best for each region. This information can be obtained in practical form for each district as the work of the survey advances.

The movement for the betterment of roads and the obtainment of information relating to the materials available for the purpose has not yet taken a national character; but it is believed that, by establishing a laboratory in connection with the Federal survey, a great impulse may be given to the improvement of highways. Such a laboratory should be arranged to obtain information as to the character of the material best adapted to road construction, tests being made of specimens sent to the survey by the various road commissioners immediately interested, by geologists surveying areal geology, and by public-spirited citizens interested in the making of good roads. During the present year the survey is temporarily using a laboratory, under the direction of Prof. N. S. Shaler, at the Harvard Sci-

entific School, Cambridge, Mass. Attention has been called to the use of bricks for highways, such as have been used for centuries in Holland and the lowlands of Europe. It now seems not only likely that this kind of pavement may become of great value in the south and the lower Mississippi Valley, but also important that the investigation of the clays of the country, with reference both to distribution and burning qualities, should be undertaken. Much information is at hand concerning the clays of many portions of the country, but little attention has been paid to their availability for making paving bricks.

Limitations of Economic Work. There have been and will continue to be differences of opinion as to the line to be drawn in economic work between that belonging to the States and individuals and that coming fairly within the field of the Federal survey. Broad interstate problems are clearly of the latter class, also those that by full study and elucidation will aid development in other areas. A test of the value of a high order of areal and economic work is brought out by a comparison of old and new conditions in the Rocky Mountain region. When the country was new, prospectors made many discoveries, and often accumulated fortunes with pick, shovel, and pan. These conditions have begun to pass away; and the mining industry now demands the highest skill and every assistance that can be given to it by geology and its collateral branches. The mining expert who is equipped with a full knowledge of the geology of the district in which he is working will succeed where the untrained man would fail. The new conditions will dominate even more in the future, rendering necessary a full knowledge of the geologic conditions surrounding mining problems. The work of the survey is not that of the prospector, nor that of the mining engineer who develops the property—that is the work of the individual, company, or community. The Geological Survey will give them the maps and the geologic data, and, if it will, the State can also aid by having analyses made for the prospectors, as well as detailed examinations and reports of special properties and of special methods of mining, treatment of ores, types of mining machinery, etc. Cases will arise when the study of a general problem will require the geologist of the Federal survey to make minute and detailed study of a mining district; but, as a whole, the work of the Federal survey is preparatory to the more detailed economic work of the State survey. The former will deal with broad interstate problems, and, when the States request it, co-operate in making a topographic map, and in the working out of such geologic problems as are germane to the work of the Federal survey.

THEORETIC WORK.—One of the criticisms often made of Government scientific work is that it is too theoretic in character and

not sufficiently practical. In the case of the Geological Survey it has been said that the people needed practical results to assist them in their material development, and that abstract studies should be left to the universities and technical schools. The critics fail to recognize the fact that scientific or technical knowledge is necessary to the solution of any geologic problem, and that, if it is not already in existence, investigations must be made in order to obtain it for the purpose. Geology is essentially a science of exploitation; and the geologist must have at his command the best instruments and most reliable information that can be obtained to aid him in observing, in recording the results of observation, in classifying and assimilating such results, and in correctly interpreting them. He must also have a knowledge of the principles and laws that govern the phenomena under investigation, and if it is only by experimentation and special research that he can obtain such knowledge, then the time and energy must be expended to secure it. In view of these facts there is no necessity for apology for the existence of chemical, lithological, physical, and paleontological laboratories in connection with the Geological Survey, nor for special studies in the glacial formations, the physics of the earth's crust, etc. They are all essential to its scientific and practical work, and to the securing of results that will command the confidence of all who may have occasion to use or refer to them. The survey will keep in view the fact that it receives its support from the people, and endeavor to give in return practical results, and at the same time to furnish information that will advance the higher education, and especially the science of geology, in America.

CO-OPERATION.—The recommendation of the National Academy of Science, that "all mensuration surveys be consolidated under one organization," was not adopted; nor could it have been fully successful as outlined in the plan submitted to Congress. If the topographic surveys were governed by any other condition than that of being made principally for the geologist, in the territory where his work demands the maps, they would be more likely to prove a hindrance than an assistance to him. An illustration may explain this. During the past field season it became desirable to make a geologic survey of the western Maryland coal field. The old topographic map of that area being found inadequate to supply the data required, a topographic party was sent with the geologists; but as the season advanced it became apparent that the one topographic party could not keep pace with the geologists, and a second and third topographic party were sent to their assistance. Jointly they completed both the topography and geology of that area before the close of the season; and the maps will be published within a year of the sur-

vey. Similar cases occurred in Colorado and the southern Appalachians. It is evident that if the topographic work had been in charge of another bureau such quick adjustment could not have been made, and the economic geologic work would have been delayed a year or more. Prompt publication of economic work must be made, as its value as an aid to development decreases with every year and almost every month of delay. Thus it is that co-ordination with any other bureau in mensuration survey becomes impracticable, unless the Geological Survey controls it. The work must be carried forward in accordance with the needs of the bureau.

To promote its own work and to avoid duplication the Geological Survey uses the points established by the Coast and Geodetic Survey, the Lake Survey, and the Mississippi River Commission whenever they are available. It also furnishes data to the several bureaus and departments of the Government as they are requested from time to time.

The attitude of the Federal survey toward State surveys has been in the past to co-operate fully and freely, though commonly in an informal way; and it has uniformly encouraged the institution of State surveys. It has been disposed to encourage a division of labor whereby economic problems of a local character would be dealt with chiefly by the State survey, while the more general and usually interstate problems, which State surveys have difficulty in dealing with, would receive the special attention of the Federal survey; the latter, including triangulation, topography, paleontology, and special researches, requiring time, labor, and specialists. The Federal survey discusses the relations of the various mineral resources, such as iron, copper, phosphates, etc., to particular geologic formations; then the State surveys come in with their independent organizations and fix the values, methods of development, and other questions relating to the local geology and mineral resources. Partial co-operation between the Federal survey and several State surveys has been thus effected, the States making use of the results of the national work, and, in return, furnishing the Federal survey with data resulting from their more restricted and detailed economic work.

Co-operation in topographic mapping has been effected in Massachusetts, Connecticut, Rhode Island, and New York, under an arrangement by which each State pays one half the cost of the work, scale and other details being agreed upon by a commission, or an officer representing the State, and the director of the Federal survey. It is essential that uniformity of methods and results should obtain throughout the topographic maps, and to secure this the execution of the field work and the drafting and engraving of the maps have been entirely in charge of the Fed-

eral survey. If agreeable to the States, co-operation will be continued on essentially the same conditions in the future as in the past.

RELATIONS TO AGRICULTURE.—The work of the Geological Survey touches the interests of the agriculturist by furnishing data in relation to the distribution and supply of mineral manures, marls, phosphates, etc., and the distribution of soils. The soils are the direct result of the decay of rocks, and in the non-glaciated areas of the United States the geological maps, showing the distribution of the rocks, are practically soil maps, as the clay, lime, sand, and other constituents of the rocks are the chief ingredients of the soils. The maps of the superficial deposits within the glaciated region will show the distribution of the different types of soils produced during the drift period, and those of the deposits without the glaciated region, the drift materials deposited in the river valleys.

In the arid and semi-arid region all questions of the occurrence and distribution of artesian water and water supply for irrigation are of great importance to the farmer, and a knowledge of the underlying geology will be of service in determining extended systems of drainage in areas provided with abundant water supply by precipitation. The study of the materials entering into the construction of highways is also of moment to the farmer, as good roads mean so much to his industrial and social development.

It is not practicable adequately to summarize in a few paragraphs the results of the work of the survey for the period 1879–1894. A somewhat full statement has been made in the fourteenth and fifteenth annual reports of the director of the survey. But, in brief, it may be said that there are completed of topographic surveys, six hundred and eight thousand six hundred and fifty square miles, of which five hundred thousand are available for areal geologic mapping; of geologic mapping, one hundred thousand square miles, of which sixty thousand are ready for the engraver; of special geologic and miscellaneous investigations, fifteen large annual reports, one hundred and sixteen bulletins, and twenty-four monographs. Many thousand topographic and special geologic maps have been printed and distributed, and, what is most important, a material and intellectual equipment has been assembled that will have a marked influence in all future work.

Under the statutes the function of the Geological Survey is to make a topographic and geologic map of the United States, and to continue the examination of its geologic structure and mineral

resources and products. To accomplish this successfully, unity of thought and purpose is essential among those engaged in the work; and the survey should be carried on as a strictly scientific investigation, with the view of aiding in every possible manner the development of such material industries as are affected by its operations. These industries include mining, hydrographic and engineering work, and any practical object that can be advanced by a knowledge of the surface and interior of the earth and its resources.

The immensity of the work which is now before the Geological Survey would be sufficient to discourage the attempt to complete it, if the review of the past and the importance of the results to be attained, both to science and to the people of the country, were not kept constantly in view. The results of the past, however, are not a true index of the character and progress of work for the future, as a great amount of energy and time has been spent in preliminary studies and experimentation as to the best methods to be pursued and in obtaining a large amount of data necessary to the satisfactory prosecution of areal geologic work. These will not have to be repeated in the future.

The plan for the immediate future is to continue topographic work in areas of primary geologic importance, and to do such other topographic work as will be of service to the people and aid in the development of the areas mapped. In areal geology it is proposed to continue work in the following provinces: 1. The coal and iron region of the Appalachians from Alabama to the Pennsylvania line, which is considered especially important, as there is a large area of the Mississippi Valley and Atlantic coast which draws its coal and iron supplies from this region. 2. The crystalline areas of the eastern Appalachian region, in which gold, corundum, mica, etc., occur. 3. The phosphate deposits of Florida, extending the inquiry northward into Georgia and South Carolina and possibly into the areas of southwest Tennessee. 4. The marls, etc., of New Jersey, Delaware, and Virginia, working southward as rapidly as topographic maps are completed and the areal geology can be surveyed. 5. The northeastern section, where the mapping and study of the roofing-slate region of New York and Vermont, and the mapping of the areal geology of Massachusetts, Connecticut, and Rhode Island, are to be completed; and surveys will be extended to such areas of Vermont, New Hampshire, and Maine as the available means will permit. 6. The Lake Superior iron region, where areal and structural work will be carried forward systematically for the purpose of mapping the extent of the known mineral deposits and of determining the existence of other deposits not now known. 7. The Rocky Mountain area, where it is proposed to continue the investigation

and mapping of the gold, silver, and coal-bearing rocks of Colorado, Utah, Wyoming, Idaho, and Montana, and, if feasible, to begin work in Arizona and New Mexico. In this connection detailed studies will be made of such typical mining districts as will throw light upon and aid in the development of similar districts elsewhere. 8. The Pacific slope: The mapping and study of the gold belt of California has been greatly advanced, but a number of years will be required to complete it, and this will be one of the essential features of the work in this region. Areal work will also be continued in southeastern Oregon; and it is planned to begin the mapping of the coal areas of Washington, and the study of the coal resources of the Pacific slope. 9. The interior southwest and the region of the Great Plains, from the Rio Grande to the British boundary. In this broad area special attention will be given to areal mapping, and also to the mineral resources in coal, iron, lignite, cement clay, building stones, the occurrence of artesian water, etc.

The resources of the interior Mississippi basin are more generally known, and the work there will be of a special character, or in co-operation with State surveys.

The investigation of the water resources of the arid and semiarid regions and of the country at large will be systematically carried forward until the available water supply from every artesian source and from every stream in the United States is accurately known, both for irrigation and power. This project, if carried out, will cover a number of years, and it will doubtless repay the outlay in the assistance it will give to the development and prosperity of all sections of the country.

If the proposed amendment relating to the geology of highways is adopted by Congress, material entering into road construction will be obtained by field parties of the survey and also through State surveys, road commissioners, and individuals; and tests will be made to enable all who are engaged or interested in the construction of highways to make an intelligent selection of materials to be used. It has been said that the status of a nation's civilization may be estimated by its facilities of communication within its own borders. Believing this to be true, the policy of the Geological Survey will be to assist in perfecting all roads by addressing itself to the purely geologic question of choice of materials entering into their construction.

The investigation of the phenomena of the great ice invasion of the north will be continued until all of its important features have been studied and interpreted, and the formations resulting from its influence, direct and indirect, have been determined and mapped.

It is also proposed to co-operate with individuals and State

surveys, wherever such co-operation will advance the work of the survey in accordance with its general scope and plans and will assist the local surveys.

The division of engraving and printing has been very successful in its work on the geologic folios; and it is hoped that arrangements can be perfected and authority secured for engraving and printing under its immediate direction all the maps of the survey.

Such special studies will be made in the chemical, paleontological, petrographical, and physical laboratories as may be needful to solve the problems that arise in connection with the areal geology or in the investigation of important scientific and economic problems.

The legislative branch of the Government has been very liberal in the past, and it is anticipated that the work will be fully sustained in the future. On the part of the survey it is proposed to retain the services of the most capable men that can be secured; to maintain the work at the highest standard of efficiency possible; and to advance it as rapidly as the means provided will permit.

THE THORNS OF PLANTS.

By M. HENRI COUPIN.

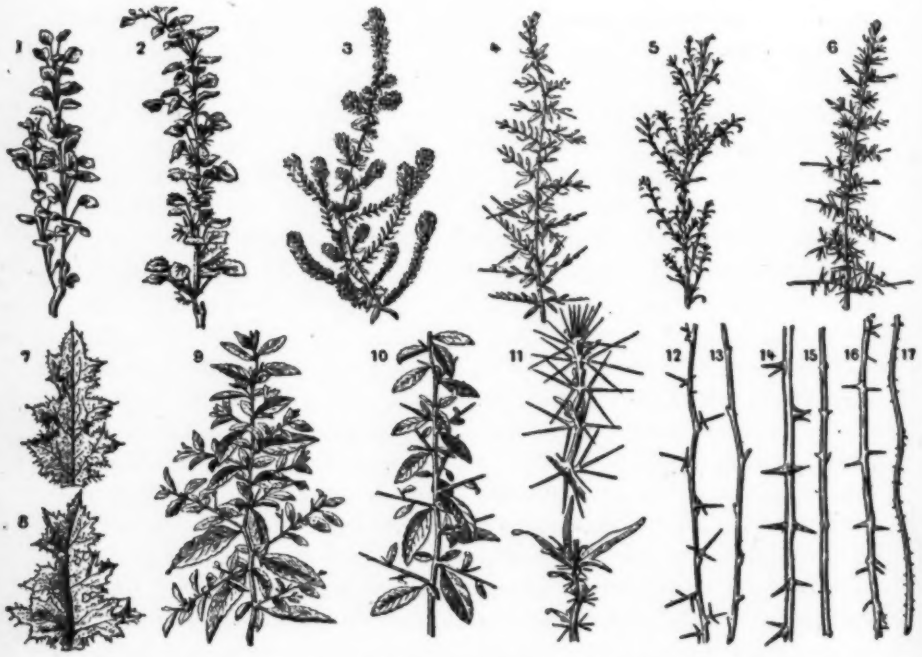
THE seeming absence of means of defense in plants, putting them in contrast—to the eye—with animals, which are bountifully and variously armed, is only apparent. A not very close examination of the behavior of plants toward animals, their great enemies, will soon satisfy one that they have many protective organs, some of them very efficacious. The spines, thorns, and prickles with which the stems and the leaves of some plants bristle are known to all, and we can hardly fail to perceive a protecting function in the aggressive defense of plants against animals and against the hand of man put forth to pluck them. In the spring, for instance, when vegetation is very little forward, the plum trees would soon disappear completely under the attacks of cattle, sheep, horses, and other foliage-loving animals, if Nature had not provided them with those long, sharp spines that make browsing of them very difficult if not impossible. The shapes of thorns are various, but may always be brought back to a protuberance broad at the base and pointed at its free end, and of an extremely hard consistence. Usually simple, they are sometimes bifid or trifid. Their positions are various. All the organs of plants may be said to bear them: the stem, as in the rose; the base of the leaves, as in the barberry; the leaves, as in the thistle;

the floral parts, as in the thistle; the fruit, as in *Datura;* and even the roots, as in *Acanthus rhiza aculeata.*

The body of plants is, we all know, composed of three members—the root, the stem, and the leaf. In determining with which part to class the thorns, an important distinction should be made, which, unfortunately, can be perceived only by the aid of the microscope. Some thorns, like the stem, leaves, and roots, contain vessels that bring up the sap, while others are destitute of them. The unvesseled thorns, simple risings of the superficial tissues, are scattered without visible order over the body of the plants. The vesseled thorns, on the other hand, are disposed in a fixed and regular manner, easy to be comprehended, for they are modified members, as the vessels running through them prove. Many thorns originate in transformations of branches; a form very evident in the plum tree, on which the thorns frequently bear flowers. Sometimes, too, they proceed from leaves, as in the barberries, or from parts of leaves, as in the agaves, or from stipules, as in acacia. Often both leaves and branches are sharpened, as in the rush and the broom. In this case, if in any, we can say that Nature employs various means to reach its ends.

Thorns are interesting, not only on account of their functions and their morphology, but also on account of the modifications they exhibit in different situations. A plant, for example, richly armed with thorns in one region, will have fewer in another place, and none in a third. It is observed that the influence of the medium in these different regions makes itself felt in the same way on all the thorned plants that inhabit them. The flora of the steppes, which extends over vast arid plains, and the flora of deserts comprise more thorny species than the flora of forests. So it is in Senegal, a country remarkable for prolonged dryness of the atmosphere and the intensity of the solar light. M. Antoine Martin has remarked that similar conditions are observable in France, where in dry, bare places, as at the Grand Camp, near Lyons, the vegetable carpeting is constituted of plants with reduced leaves or thorns, such as *Genista, Ononis spinosa,* and *Eryngium campestre;* by which it is given an appearance comparable with that of desert regions. Thorny plants are especially prominent in deserts, where vegetation is subject to the triple stunting action of dryness of the air, aridity of the soil, and intense light. On the question as to which of these causes is the one that influences the production of thorns, an interesting memoir has been published by M. Lothelier, of the Sorbonne. He employed in his investigation the scientific and fruitful method adopted at the laboratory of Prof. Gaston Bonnier, which consists in subjecting many individuals of the same species of plant to identical conditions of light, moisture, and temperature, and then

introducing variations of one at a time. Then, whatever differences are observed in the results obtained at the end of a certain time, are evidently due to the factor which has been changed. In studying the modifications caused by the hygrometric conditions of the air, M. Lothelier capped two specimens of barberry with a long cylinder of glass, along which he placed broad-mouthed flasks of sulphuric acid to absorb the moisture of the air; and two other plants with a similar tube along which were flasks filled with water. These two lots of plants, growing side by side under



PLANTS WITH THORNS.—1 and 2, *Berberis* (barberry grown under moist and under dry conditions); 3 and 4, *Genista*, or broom, moist and dry; 5 and 6, *Ulex*, or furze, moist and dry; 7 and 8, *Cirsium*, moist and dry; 9 and 10, *Pyracantha*, moist and dry; 11, *Xanthium*, upper sprig moist, lower sprig dry: 12 and 13, *Gleditschia*, or honey locust, grown in the sun and in the shade; 14 and 15, *Robinia*, or locust, grown in the sun and in the shade; 16 and 17, *Rosa*, grown in the sun and in the shade.

the same conditions of light, temperature, and watering, were then experimented upon for about six weeks, at the end of which it was found that the new leaves of the plants in dry air were spiny, while the leaves of the two in moist air were well developed, and had acquired long petioles. Like experiments were instituted on other plants, with always the same results; the differences of appearance presented by these plants as they grew in dry or moist air were really remarkable, and so great as almost to suggest that they were of different species.

An interesting observation was made that the disappearance

of the thorns in moist air was effected in two different ways. The thorns, when they possess the morphological significance of a limb of the plant, whether of a leaf, as in *Berberis*, or a bough, as in *Ulex*, have a tendency in the saturated air to return to the normal type. When they proceed from organs that are not indispensable to the life of the plant, whether from a stipule as in *Robinia*, or from a stipule peduncle as in *Xanthium*, they tend constantly to disappear by retrogression.

The influence of light on the production of thorns was studied by M. Lothelier in a similar manner. His results were for the most part parallel. Shade tends to suppress the thorny parts of plants. The tendency is exhibited sometimes in a return to the normal form of the organ; but more frequently the thorns suffer a greater or less atrophy in the shade.

It is evident, then, that the conditions that most influence the production of thorns are especially dryness of the air and intensity of light. There are also, doubtless, other conditions of life that act in the same direction. I recollect having seen a cultivated and a wild olive tree growing side by side in the south. Only the latter had thorns. This even seems to me to be a general law which M. Lothelier has unfortunately not touched upon—that wild plants lose their thorns when they have been cultivated for several generations. It seems as if the plant, when brought under the protection of man, gradually gives up its defensive arms, which are thenceforward not needed, since its enemies are kept away by the care of its master.

The office of thorns is not limited to defending plants against herbivorous animals. With a number of plants, particularly those which form long shoots and live in thickets, thorns, usually curved downward, help hold up the stems. When thorns are localized on flowers, fruits, and seeds there seems generally to be a purpose of aiding in the dissemination of the seeds by enabling them to hook themselves in the fleeces of animals that come to graze among them. The thorns then serve for the defense of the species rather than of the individuals. The seeds which are aided by this mode of dissemination are called zoöphiles, while those which are adapted to dissemination by the wind are called anemophiles.—*Translated for The Popular Science Monthly from La Nature.*

DEAN BUCKLAND'S interest in hyenas, whose remains and the remains of their feasts he found in the Kirkdale Cavern, caused some amusement to Lyell, who is quoted in Mrs. Gordon's Life of Buckland as writing to Mantell in 1826: "Buckland has got a letter from India about modern hyenas, whose manners, habitations, diet, etc., are everything he could wish, and as much as could be expected had they attended regularly this course of his lectures."

SOME MATERIAL FORCES OF THE SOCIAL ORGANISM.*

By Prof. JOHN W. LANGLEY.

AT the outset of this paper I wish to define one or two terms, and my own position in using them. The expression "the social organism" is generally taken in a merely figurative sense, but to me it has more significance than that. I will employ it with nearly its full literal meaning.

Society, denoting by that the people collectively of any one nation or government, is an organism distinctly endowed with the attributes of a living structure. Its individual units, men and women, are alive; its various political parties, charities, industrial groups, and its government all have an organic character; and, finally, the whole society shows the fundamental attributes of vitality in the specialization of parts, the partial co-ordination of these for a common end, and particularly by the constant phenomena of mutation and change.

The social organism is, then, a vitalized structure, not only in its separate parts but in its entirety. Now, if this is so, then many of the conditions which modify the more familiar forms of life may be expected to, indeed necessarily will, influence and modify the progress of social development and growth.

Foremost and most obvious of these conditions will be the character of the raw material of society—I mean matter, substance, material things. For, just as a brick house differs from a wooden one, even if the general plan is the same, because one is made of mineral matter while the other is vegetable; or, as a porcelain vase will differ from a bronze one of exactly the same shape by all the fundamental properties belonging to clay and metal, so equally must the possibilities of social conditions be fundamentally controlled and limited by the properties of matter.

There is a very different view from the above, illustrated by this quotation from Bishop Berkeley: "Some truths there are so near and obvious to the mind that a man need only open his eyes to see them. Such I take this important one to be, namely, that all the choir of heaven and furniture of the earth—in a word, all those bodies which compose the mighty frame of the world—have not any substance without a mind."

But the question I raise here is not one between the Berkeleian or the anti-Berkeleian philosophy, or between idealism and materialism, because for the practical purposes of this paper it makes no difference in which camp we stand; and while the language

* Delivered before the Cleveland Council of Sociology, June 25, 1894.

will necessarily be somewhat materialistic in terminology, because we are dealing with material things and material forces, the writer does not wish his words to seem to be conditioned by any metaphysical system.

Practically speaking, we are dealing with concrete things—stones, bricks, men and women, society. The materialist says they evolved themselves; the idealist says they were made by an outside agent; but for the purposes of this paper it is all one and the same, because any structure, whether self-created or manufactured by intelligence, is largely conditioned by the substance out of which it is made.

Now, how is society conditioned by that out of which it is made? How do the general properties of matter enter into the natural history of its development? That, I think, is a very interesting and a vitally important question if it could be answered in its entirety, but no one can do this for us yet. All we can do is to pick out a few characteristics so obvious that perhaps they will seem only trite. But granting they are so, still, it sometimes happens that the familiar and the commonplace take on new features when looked at from fresh standpoints.

The first thing, then, to be noted in regard to circumscribing conditions is that the inherent strength of materials puts a limit to the possible size of any structure, whether artificial or natural. As an example, consider a cannon: The actual size of a big gun is not limited by its weight, for much heavier ordnance than any now made could be handled by modern machinery; what stands in the way is the tensile strength of the metal employed. As soon as the pressure of the exploded powder upon a square inch of the internal surface of the gun is greater than the elastic limit of the steel, the metal will give way by stretching. This will enlarge the surface of the chamber, which will thus offer fresh portions for the action of the pressure, and so the operation will go on until rupture takes place. There is thus a certain powder pressure beyond which no thickness of metal, however great, can prevent bursting; this limiting size is already nearly reached in recently built cannon, and nothing but the discovery of some new metal or alloy stronger than steel will enable us to build guns materially larger than those now made.

Another instance is found in bridge work. As the spans grow longer, the proportionate load they can carry grows smaller. It is easy to calculate from the known properties of iron just how long a span must be to barely sustain itself. Nothing longer than this could stand, because, when the weight of the bridge puts a stress on its members greater per square inch than the breaking stress per inch, the bridge must fall, even without any extraneous load. In living creatures the same condition is found. No land animal

is as large and heavy as a whale, because the bone and muscle of which they are made would be incapable of supporting so great a weight. In the water, however, it is different; the huge mass is evenly supported by the water in which it almost floats, thus relieving the anatomy of the whole from nearly all stresses due to gravity.

The same cause has operated to make all inhabitants of the air small. No very large bird, say as large as a horse, is known, and not even the extraordinary creations of past geologic ages show us any examples of very large flying creatures. The necessary relations between velocity of wing movement, weight, and size might be found for a flying elephant, but the intrinsic strength of living tissues would prove too weak to sustain so large a mass in the air by muscular exertion. So it is apparent that it is the intrinsic strength of living tissue, and not weight alone, which limits the size of aërial creatures.

The second general relation between substance and structure may be stated thus: "The nature of matter puts a limit to the intensity of action."

This proposition is nearly self-evident, and needs only one or two illustrations. All living structures consist largely of water. In the actively growing portions of vegetables upward of sixty per cent of the weight is water, while in animals more than seventy-five per cent of the weight of the whole body is represented by the same liquid. Physically and chemically speaking, life is chiefly an aqueous phenomenon. Now, as water forms steam of a quite sensible pressure at temperatures a little over 100° F., while it becomes a solid at 32°, we see that this property of water would alone be sufficient to account for the fact that living creatures can not grow and propagate outside of these temperature limits, while if they are somewhat exceeded, even the smallest and most resisting forms of life, the so-called germs, are permanently killed.

Again, the rate of nerve transmission in warm-blooded animals is about one hundred and fifty feet per second. A peripheral sensation takes a sensible time to reach the brain, another interval for the brain to act, and a third for the order to be executed. Herein lies the explanation why we are burned by unintentional contact with fire. All the time during which the message to and from the nerve center is being transmitted, the finger is passively lying in the flame and chemical destruction of tissue is going on, so that by the time the finger gets the order to move it has become badly injured.

If the nerves could take up and transmit a stress with the intensity and velocity of a copper wire carrying electricity; if the brain could act with the promptitude of a Leyden jar, and the

muscles move like the snap of a steel trap, no one would ever be burned in those cases where freedom of bodily motion was possible. Thus the slowness of these processes resulting in injury to the body is, from the physicist's standpoint, a defect, but it exists because the nature of the matter out of which the man is built puts an undesirable limit to the intensity of action.

If we leave now the consideration of the static properties of matter, and view it in its dynamic aspect, we encounter a generalization of the widest significance. The most notable thing about the universe is that it is the scene of incessant change. Absolute stability is unknown; no single thing living or nonliving is exactly the same for two consecutive hours. Even those phenomena which stand as types of the permanent, the revolution of the earth and the position of the stars, are now known to be undergoing changes which, though exceedingly slow, are nevertheless constant and ever progressing toward some future condition whose character we know not, but which we are certain will be as fleeting and transitory as the present.

If "all our yesterdays have lit the way to dusty death," then is it not also equally true that all our to-morrows will usher in new and unknown forms of resurrection?—for, I take it, the material universe of stars and planets, the great globe of the earth, the movements of matter and the sequences of life, all tell one impressive story, which is, that to undergo change, endless change, is the sentence pronounced on everything built of matter and having its share of the universal motion around us.

But while there seems no escape from the above conclusion, there is another generalization equally great, which is its supplement; this is, that the changes are not chaotic: everywhere there are method, rule, law; and these laws, as we interpret them, are the unchangeable elements of the universe. The method by which a given result is produced is not exhausted by that result. The rule that all living things must die will still remain unimpaired when the last man shall have sunk into his grave. The law that all things shall change is itself enforced and executed by that change, so that *it* remains permanent while the forms and agglomerations of matter are fleeting.

Now, the purpose of this paper, to which the above is a peroration rather than an argument, is to show that social changes, like other mutations, are governed by law. The discovery of these laws will constitute the *science* of sociology, just as in nonliving things the same kind of study is called physics or chemistry. The application of these laws will give us an *art* of sociology, very much as pure science finally culminates in engineering or medicine.

Religion excepted, the study of sociology as a pure science

seems to me to be the highest field for the exercise of our intellectual faculties, for it includes ethics on the one hand and psychology on the other, both together constituting the phenomena of mind, while the visible results are conditioned by the attributes of matter. But to-night I propose to begin on a much lower plane, and to attempt only the suggestion of one or two simple laws which are common to nonliving structures, to living beings, and to an organized society.

Since the metamorphoses of matter are endless in number and infinite in succession, let us limit the word "change" to some fixed and definite alteration, such as the burning of an ounce of gunpowder, the falling of the water of Lake Erie over the cliff at Niagara, or the duration of a human life from infancy to old age. In this restricted sense physicists and chemists have recognized two kinds of changes: first, those which tend to go on indefinitely until all the matter present has suffered the alteration in question; second, those which give rise to products which are unfavorable to the original forces at work—such changes are self-limited and may cease, therefore, long before all the material has been used. As an example of the first type—that of unlimited change—I may again cite Niagara, for here the falling water sets up no reaction against itself. This is the popular idea of a change, because we seem to be surrounded only by such cases.

The falling snow or rain, the uprooting of trees by a whirlwind, the constant streaming away of light from a lamp or heat from a stove, with the concomitant burning of fuel, all are familiar experiences and they are unlimited in character. But while these and others like them have served to stamp the word "change" with a definite meaning in the mind of the public, it is because they seem the only types to a superficial observation. In reality, however, the other kind, the self-limited changes, are vastly more numerous. Take as an example the freezing of water: the moment ice is formed it acts as a partial nonconductor, or blanket, to keep heat from escaping, and so the rate of freezing is diminished, and here in our climate is wholly stopped when a thickness of two feet of ice is reached. Or, again, consider the case of an elastic body on which a weight is placed. If it is a spring, it will bend, and finally, if the weight is not too great, will reach a position where the latter is just supported. This equilibrium is brought about by the internal stress of resilience of the spring acting against the force of gravity, and thus the change in position of the weight has called forth a power which is the result of that change, and at the same time limits it in amount.

While this illustration is an elementary one, it is for all that exceedingly important, because it is so common; it covers every

case of mechanical stability, whether of a house, a tree, a mountain, or a man walking.

There is another term to be considered in this connection which is used by physicists frequently in a special sense, and that is the word *system*. An open system is one in which the products of a change do not return into themselves, as, to repeat illustrations already given, a waterfall, a fire, or a whirlwind. A closed system, on the other hand, is one in which these products are retained, or at least the internal changes of shape or stress do not travel away; a pendulum might be spoken of as a closed system, because, while gravity causes it to move down to the lowest portion of its arc, the motion thus acquired carries it beyond this point and up the other side, thus converting actual into potential energy, and this alternate conversion and reconversion will go on forever in the absence of friction. Some machines may also be considered under this head, as a stationary steam engine. The apparatus is indeed receiving steam at one end and dispensing mechanical power at the other, but on the average these balance, leaving the machine as the seat of many complicated stresses playing back and forth against each other. In this respect the engine is a closed system.

Now, it may be laid down as a general proposition that self-limited changes occur only in closed systems. Also that any organized structure, and more especially a living animal, may be considered as a closed system; for, though it is true the animal is dependent on food, and is constantly giving out heat and other forms of energy, still, for any moderate period of time these balance each other, while the organism as a whole is dependent for its integrity upon a constant regulation of its internal states through incessant changes, which, moreover, must be self-regulating in character. Life is but a sequence of these delicately adjusted actions and reactions. Physiology is full of instances of this fact. One illustration may suffice. When a muscle is exercised, a portion of it is oxidized or burned. Some of the products of this oxidation are acids, but the vitality of a muscle is diminished by the presence of an acid. The sense of fatigue is the language by which the nerves inform the brain of this muscular state, and the mandate, Let the organ have repose, is only another way of telling the scavengers of the body to go and take that acid away. Here, then, the law is illustrated; the voluntary change in the muscle, represented by its work, sets up a chemical force which limits and finally stops the change by which it was produced.

One machine, more than any other I know of, represents the play of self-limited forces admirably. It is the alternating dynamo for the production of currents of electricity. It has also many of the attributes of an organic being, and I almost feel like

saying it is alive. If we can not strictly and literally call it so, yet there are such broad features in common that I think we may study it as one of the nearest approximations by mechanism to some of the simplest forms of actually living creatures.

The general arrangement of the apparatus is as follows: A number of magnets, with their ends, or poles, alternately north and south, are arranged around a circle with the magnet legs pointing inward toward the center, but not reaching it. Within the smaller circle thus formed a few loops of copper wire wound on an iron drum revolve, but without touching the magnets or outer frame. So long as the inwardly projecting legs are not magnetized the armature, as the coils of wire are called, revolves freely, and no effort on the part of the engine or other source of power is required to turn it except sufficient to overcome the slight mechanical friction of the shaft. Also, if the magnets are excited and the copper wire of the armature does not have its ends joined so as to form a complete return path, there is no opposition to the rotation. But when both of these conditions are supplied—viz., the magnets, also called the "field,"are excited and the armature wire joined to itself—then a mysterious and extraordinary resistance to motion at once occurs. If we are turning the armature by hand, it feels as though we were forcing it through thick jelly. If more force, such as that of a steam engine, is applied, it may take many horse power to revolve the armature rapidly, and yet there is no scraping or contact between the surfaces of the armature and field, nothing giving rise to ordinary mechanical friction, and nothing directly corresponding to the ordinary losses of power in other machines.

This wonderful result has been analyzed into three fundamental conditions, often called causes. They are mysterious, like the original phenomenon; but, then, every appearance in Nature is a mystery to the last analysis. These three are, first, a peculiar force emanating from the ends of the field magnets and extending from pole to pole by curved paths, called "lines of force," going through space, whether filled with substance or entirely empty. They are probably lines of stress in the ether, and we know that any metallic body placed in the path of these lines is submitted to the influence of the lines of force. Whatever this influence is, it does not give rise to anything perceptible to our senses in non-magnetic matter, like copper or India rubber.

Second. As soon as the wire moves so as cut through these invisible lines of force, a new stress, called electro-motive force, is produced in it, and now the free ends of the copper wire have suddenly acquired the property of attracting each other, but the magnitude of this attraction is exceedingly small. This electro-motive force is caused in some way by motion in a magnetic field.

So soon as the motion ceases the force is gone. But it is most important to notice that no power need be exerted by the engine to call forth a manifestation of electro-motive force, because there is not as yet any appreciable opposition to the rotation of the armature.

Third. The instant the free ends of the armature wires are joined, the attraction, or potential as it is called, diminishes, a current of electricity rushes through the wire, and the mysterious opposition to rotation at once springs into existence, the belt grows taut on the driving side, the engine takes more steam and labors harder and harder, while a constant stream of mechanical power must be supplied by it to the dynamo to maintain that motion which a minute before went on so easily and freely.

The electrical current passing out from the dynamo is constantly carrying energy away from it. This loss must be incessantly supplied by the steam engine, and this demand is brought about by the opposition to rotation set up within the machine through reaction of the electro-motive force on the material of the conductor and on the magnetic lines. Thus we have here the constant characteristic of a closed system where invariably the product of a reaction opposes the primitive cause of the change.

Thus far the phenomena just quoted exemplify the rule. It would not have been worth while to take so much time to describe the dynamo if nothing more was to be learned from it, but there is. This semi-living machine, whose elements are so simple compared with those of a really living structure, enables us, because of its mechanical simplicity, to go one step further in our analysis and to inquire how the result of the change reacts on the exciting cause. It is known beyond doubt that in a working dynamo the action of the current is twofold. It not only tends to stop the armature, but it actually diminishes the magnetism of the fields, and so lessens the electro-motive force by attacking it at the very place of its origin. Let me repeat: the magnetism and the rotation create the electro-motive force; this latter creates the current; then the current in turn reacts both to oppose the rotation and to cut down its own initial cause; and, further, this reaction on the cause is found always to require an appreciable time.

Here, I think, we have struck a new principle. In electrical matters it has been known only a few years, and has had no applications in other sciences, but I venture to think it is somewhat general, and that illustrations of it may be found elsewhere, one or two of which I will endeavor to submit.

A spiral spring supporting a weight does not manifest this principle, for the cause—that is, the weight—is not lessened by the pressure it produces. The same is true of all static states; but when motion occurs, then this new principle may often be observed.

Now, there are no more perfect examples of closed systems which are the seat of constant motion than living beings, because life is a type of never-ceasing co-ordinate changes. Can instances be found in living beings? What we have to look for is a reactionary force, which not only opposes the generating stress by setting up one like it and opposite in direction, but, furthermore, as the change progresses it must tend to reduce the initial impulses which created the change, this being what I have ventured to call the new principle.

Let us once more consider the case of muscular fatigue in the light of this idea. The initial cause of muscular contraction is the nervous stimulus sent to the organ. As soon as the muscle contracts, the motion within it generates free acid. This acid, which is therefore of the nature of a reactionary product, reduces the irritability of the fibrillæ, but, *in addition*, it reduces the power of a nerve to transmit and to generate nerve force, so that not only is the mandate traveling along the nerve resisted by the greater sluggishness of the muscle, *but also* the nerve force itself, which is the material form taken by the will, is attacked and lessened in the very place of its origin.

Is this not closely analogous to the cutting down of the electromotive force of the dynamo by the current which that same force creates?

Another example, dealing with the chemical rather than the mechanical force of the body, is found in digestion. Hunger is a sensation which is probably the collective cry sent up from all parts of the organism; but the stomach and certain nerves seem to be its principal seat. The irritability of a hungry man is a well-known phenomenon. The exacerbation of many nervous symptoms due to exhaustion is familiar to physicians. Hunger, then, is an active, not a passive, state, and denotes that certain changes of a positive kind are going on which tend to proceed to the ultimate destruction of the animal if not checked. When food enters the stomach and commences to be digested that organ works harder, but the production of this labor taxes the forces of the body by calling blood away from other organs; in addition to this, the nutriment given to the nerves stops the wasteful action going on in them. So here, as in the previous cases, the reaction set up cuts down the initial cause, and hunger vanishes.

Many other instances might be drawn from physiology, but, leaving them on one side, I desire to make a few suggestions concerning that larger aggregate of life—the social state.

The warlike temperament of man has been one of his most prominent characteristics from the earliest times. To live to fight has been the chief aim of most primitive peoples, and has been a leading occupation of all civilized ones. Armies have grown in

size, weapons have multiplied in number and destructiveness, battles have grown more and more deadly in action, while also becoming more merciful in their accompaniments; but still it is everywhere apparent that, in spite of these aids to carnage, the military spirit is on the decline. May we not look for the cause of this in the enormously increased cost of warfare and its interference with the pursuit of prosperity and wealth? When the internal losses to a people become greater than those they can gain through conquest and annexation, they will be very loath to enter into a great conflict. I am very far from saying that many other causes, such as ethics and a growing spirit of mercy, may not have contributed to this pacification of the nations, but is it not true that the cost of war is the chief preventive of war? If so, does it not illustrate the rule that the reactions set up by the vast technical improvement of methods of destruction have reacted on the primitive cause of the destruction—viz., the human will—and have lessened the cause by modifying the heart and brain of man?

It is not a difficult task to point out analogies more or less vague. It is generally a safe exercise to move about in the region of diffused generalization. It is prudent to keep one's balloon in the clouds so long as the country below is full of sharp and jagged rocks; but, then, one must come down some time, and anchor the craft to some tangible thing.

Now, I must bring this paper to an end, and relate it, if possible, to some present fact, and the fact I want to tie to is the existing socialistic movement. That is rugged enough to gore anybody, and so I will approach cautiously with two or three suggestions.

A closed system, possessed of incessant internal motion and alive, is conditioned by many things, but three only of these have been touched on in this paper: First, by its size; second, by possible intensities of action; and, third, by the reactionary forces set up by changes now going on. That the size of a community tends to disrupt it no one will deny. That the intensity of effort of the whole community is dependent on the average vigor and intelligence of its members is also a truism; while the operation of the third law seems to me to lead to these conclusions: 1. The dynamic value of any social movement depends more on its past history than the immediate present. Any forecasts which ignore the past, and predict future states only by observing the momentary conditions of to-day, will be surely in error. Indeed, I would go further, and say that a visible movement is already but the autumn crop of something sown long before. 2. Any movement of a portion of the community thereby sets up a counter force, whose tendency is to lessen or abolish the initial desire which

started the movement. Socialism, as the craving of the human mind, has appeared through all history, but it has hitherto been a desire mainly, not a force. Now it has become a power, and resulted in a movement throughout the civilized world; it will grow like the current in the dynamo, but, like it too, as the leveling downward of social inequalities goes on, it will raise up such a repulsion against a dead uniformity, and especially against the loss of those things which make life most worth living—art, music, architecture, education, and religion—that crass communism and anarchy will be extinguished by that which they are now evolving, and the doctrine of personal freedom will once more arise to work in a new but greatly modified field.

THE SERUM TREATMENT OF DIPHTHERIA.

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IT is almost seventy-four years since Bretonneau submitted to the Paris Academy of Medicine a report on croup and malignant sore throat, in which he maintained that a number of differently named diseases that were characterized by a membranous inflammation of the fauces and upper part of the air passages constituted but one specific disease, for which he proposed the name diphtheria. But the confusion he hoped to dissipate by the use of a generic term was maintained until recent years, notwithstanding the familiar employment of that term in medical nomenclature. There are few to whom its sound is unassociated with dread, for old and young, rich and poor, are alike susceptible to its infection.

In 1883 Prof. Edwin Klebs discovered, and in 1884 Prof. F. Loeffler succeeded in isolating and cultivating, the micro-organism now known as the Klebs-Loeffler bacillus, that is generally accepted as the productive agent of diphtheria. These bacilli, inoculated upon an abraded mucous membrane of animals susceptible to diphtheria, produce false membranes, systemic disturbances, and even death; they are found in the nasal and throat secretions and in the diphtheria membrane; microscopically they occur in the form of straight or curved rods that stain, with aniline dyes, most intensely at the ends, and thus present a dumb-bell appearance. Imbedded in organic matter and protected from the light, the bacilli may keep alive for many months outside of the animal organism. Uncleanliness, accumulations of dirt, and particularly dark, damp rooms favor the preservation of the bacilli and the propagation of the disease. This bacillus has never

been found as the morbid agent in any other similar affection, or in a spontaneous disease among lower animals; nor is there any existing evidence to support the idea that true diphtheria may be conveyed from sick animals to human beings.

The diphtheria bacillus may be found in the air passages, especially the nose, of healthy persons, in whom it has produced no disturbance whatever, nor does it cause any indication of sickness until it has settled down for good. Lesions of the mucous membrane of the nose or throat, small eruptions in the air passages, chronically enlarged tonsils, and especially catarrhal changes consequent upon cold, damp weather, favor the development of the bacillus. If these membranes are normal, the bacillus finds insufficient material in which to multiply, and the poisonous products that it forms are thrown out with the mucus ordinarily produced; but if there is any lesion or disorder of the membranes, then these poisonous products act at first locally and cause such disturbances of the usual processes of the affected region that the bacilli multiply vigorously and form such quantities of their poison that it is absorbed into the system and the disease follows.

From the moment the bacilli are found on the membranes the person should be regarded as infected, and the term diphtheria should be reserved exclusively for those affections in which this particular bacillus is found. Not infrequently cases are met with that present the physical features of diphtheria, but a bacteriological examination will show that the condition is due to other organisms, such as pneumococci, streptococci, and staphylococci. Indeed, in 1887 Loeffler announced that, in addition to the organism identified with his name and Klebs's, there occurred in diphtheritic membranes another organism resembling it in many essential respects, but differing from it in its disease-producing power, and to this organism he gave the name of pseudo-diphtheria bacillus; these bacilli are shorter and more uniform in size than the typical Klebs-Loeffler bacillus.

The importance of distinguishing between these forms of throat inflammations is apparent when it is recalled that the specific character of the disease not only determines the necessity of isolating the affected person but also the method of treatment that should be followed. New York was the first city in which a municipality endeavored to make that distinction, and what is now known as the "New York plan" was inaugurated by Prof. Hermann M. Biggs, and his associate, Dr. William Hallock Park, of the Board of Health. In New York, as in most cities, physicians are required to report the cases of diphtheria they are called upon to treat; if the environment of the affected person renders it desirable to transfer the individual to a hospital for contagious diseases, it is a matter of importance to decide that

the disease is diphtheria. Some of the material from the suspected person's throat is obtained by rubbing the latter with a rod having a piece of sterilized cotton wound around its end, and then the cotton is rubbed over a sterilized mixture of blood-serum contained in a closed test-tube, so as to transfer any micro-organisms from the cotton to the serum. The test-tube is placed in an incubating oven and within twenty-four hours the character of the growth of micro-organisms may be decided. In one year Dr. Park and his assistant, Mr. A. Beebe, made bacteriological examinations of 5,611 cases of suspected diphtheria, and the bacilli of true diphtheria were only found in 3,255 cases, or fifty-eight per cent, twenty-seven per cent of the cases being pseudo-diphtheria, and fifteen per cent being of a doubtful character. This seems to prove conclusively that every case suspected of being diphtheria must be examined bacteriologically by an expert.

The affected person should be regarded as infectious from the moment the diphtheria bacilli are found to be present upon the mucous membranes, and, while the bacilli usually disappear with or soon after the disappearance of the local signs, yet in some cases they may remain in an active and virulent state for weeks and even months after the patient has apparently recovered. Therefore no patient should be discharged as recovered until at least two or three bacteriological examinations, made at different times, have failed to reveal the presence of the Klebs-Loeffler bacillus in the secretions of the air passages.

Diphtheria is most rapidly communicated by direct contact between the sick and healthy persons. Coughing, sneezing, spitting, kissing, holding the patient's hands, the use of utensils in contact with the patient, drink or food in the sick-room, and clothing, books, and toys may be the media for carrying the bacilli. From this it may be appreciated that the diphtheria patient must be isolated either in a separate room in the house or in an isolation ward, and that there must be thorough disinfection of all articles in contact with the patient, as well as a local antibacillary treatment of the nose and throat to remove the bacilli and thus limit the possibility of their dissemination.

When diphtheria is prevalent the best prophylactic measures are cleanliness, dryness, ventilation, and proper light in dwelling rooms; cleanliness of the nose and mouth that may be secured by thorough daily irrigation with a one-per-cent solution of common salt or a two-and-half-per-cent solution of common baking soda, used as hot as can be borne, with careful brushing of the teeth and medical care of the tonsils if enlarged or diseased; and, finally, cold ablutions of the neck.

The difficulty heretofore referred to of distinguishing, by the

naked-eye appearances, the diphtheritic from the pseudo-diphtheritic inflammation, as well as the formerly existing confusion regarding the identity of all such inflammations, at first inspired doubt in the minds of many investigators that the Klebs-Loeffler bacillus caused diphtheria, especially as it could be injected into animals without producing diphtheritic paralysis. But in 1888 Roux and Yersin found that such injections would kill animals if the bacilli were introduced in sufficient number and sufficient degree of virulence; and, further, that the growth of the bacilli in culture fluids produced poisonous substances, called toxines, so that if the cultures were passed through a porcelain filter in order to remove all the living germs, the filtered liquid would produce exactly the same symptoms, and consequently the microbe only acted through its toxines.

The toxine is produced by the cultivation of the virulent diphtheritic bacillus in broth, in contact with the air. Flat-bottomed flasks that have lateral tubes, and that contain a thin layer of a two-per-cent peptonized alkaline broth, are sterilized in an incubating oven, and then a fresh culture of very virulent diphtheritic bacillus is added to the broth. The flasks are kept in the oven at a temperature of 98° F., and by means of the lateral tubes moist air that has been passed through a wash-bottle is constantly kept passing over the broth; within from three to four weeks a culture that is rich in toxines is obtained, a thick layer of bacilli covering the bottom of the flask. All diphtheritic bacilli do not furnish the same quantity of toxine in cultures, nor is the power of the toxine the same in cultures that are apparently made under the same conditions. When the cultures are completed they are filtered by a Chamberland filter, and the clear liquid is kept at the ordinary temperature in well-filled, stoppered bottles, that are protected from the light. A dose of one tenth of a cubic centimetre, about a drop and a half, of this toxine usually kills a guinea pig weighing five hundred grammes, or one pound, within from forty-eight to sixty hours.

Pasteur's success in producing immunity to chicken cholera, anthrax, and rabies by the inoculation of toxines produced by those diseases has stimulated other investigators to seek out methods for producing immunity to the infectious diseases affecting man. Prof. Carl Fraenkel first immunized guinea pigs against diphtheria by injecting them, with great care, with diphtheria toxine modified by heating it at a temperature of 70° C. (158° F.). Subsequently Behring commenced his experiments regarding the production of immunity, and injected animals with a mixture of the toxines and iodine trichloride, though to-day he injects very small doses of pure toxine at sufficient intervals for the animals to rest comfortably. Brieger and Wassermann pro-

duced immunity by injecting a culture of diphtheria bacilli in a broth of thymus gland, after having heated it at 65° to 70° C. (149° to 158° F.) for a quarter of an hour, they having assumed that the thymus extract exercised an antitoxic influence on the specific diphtheria toxine. Roux and Vaillard immunized animals by a mixture of three parts of toxine and one part of Gram's solution of iodine, the substances being mixed a few moments before they were injected beneath the animal's skin. Roux found that a rabbit of medium weight easily supported an injection of half a cubic centimetre of that liquid, and after a few days the injection could be renewed and so continued during a few weeks, when the injection would be increased in quantity or the pure toxine might be administered. He also found that it was necessary to frequently weigh the animals and to interrupt the injections when they lost weight, otherwise a depraved condition of the animal's system developed, that might terminate fatally. Animals thus immunized may be injected with a dose of toxine, or a quantity of culture of virulent bacillus that would ordinarily be fatal with but little if any unpleasant effect.

In 1890 Behring demonstrated the fact that blood-serum taken from an immunized animal was capable not only of producing immunity from the same infectious principle in another animal, but, further, that it possessed the power of curing an infection already in progress. This latter remedial employment of serum containing some antitoxine is called serum therapy. The serum is called an antitoxine serum because it contains some agent that antagonizes the toxine.

Besides the serum, Ehrlich, Roux, and others found that the milk of goats and cows that had been immunized was a source of antitoxine, though such milk was much less active than the serum.

The investigators found that of all the animals capable of furnishing large quantities of antidiphtheritic serum the horse was most easily immunized. Roux frequently found horses in which the injection of from two to five cubic centimetres of strong toxine beneath the skin provoked only a transient fever and a local swelling that quickly disappeared. The cow and the ass were found to be much more susceptible to the action of the toxine. Behring held that the antitoxic properties of the serum furnished by an immunized animal were greater in proportion to that animal's sensitiveness to the action of the toxine. But Roux did not consider this an established fact, and since 1892 had employed horses for immunization against diphtheria, because horse serum was not harmful when injected into lower animals or man, and from the jugular vein of a horse large quantities of blood might be obtained from which a perfectly clear serum could be separated.

The horses selected for the purpose of supplying serum should, Roux states, be ordinary coach horses from six to nine years old, well nourished but incapacitated for work on account of some injury of the limbs. Such horses must be carefully examined to determine the absence of lesions of the internal organs, especially of the kidneys, while the absence of tuberculosis or glanders must invariably be determined by a failure of the animal to react to an injection of tuberculin or mallein.* Roux reported the details of the process in a horse seven years old, weighing four hundred kilogrammes, that was injected beneath the skin of the neck or behind the shoulder with toxine, one tenth of a cubic centimetre of which sufficed to kill a guinea pig weighing five hundred grammes in forty-eight hours.

Day.	Injected.
1st	½ c. c. of toxine with ten per cent iodine. No local or general reaction.
2d, 4th, 6th, 8th	½ c. c. Do. Do.
13th, 14th	1 c. c. Do. Do.
17th	½ c. c. of pure toxine. Slight reaction.
22d	1 c. c. " " " "
23d	2 c. c. " " " "
25th	3 c. c. " "
28th, 30th, 32d, 36th	5 c. c. " "
39th, 41st	10 c. c. " "
43d, 46th, 48th, 50th	30 c. c. of pure toxine. Œdema that disappeared in twenty-four hours.
53d, 57th, 63d, 65th, 67th	60 c. c. of pure toxine.
72d	90 c. c. " "
80th	250 c. c. " "

In two months and twenty days this horse received more than eight hundred cubic centimetres, or twenty-five ounces, of toxine with no worse symptoms than transient local swelling and temporary rise of temperature about one degree centigrade. Serum was obtained from this horse by bleeding it on the eighty-seventh day, and immediately thereafter two hundred cubic centimetres of toxine were injected into the vein with but moderate subsequent fever. The latter procedure is less efficacious than injecting smaller doses of toxine from time to time and allowing the animal to rest for twenty days before being bled again. Roux has horses from which blood has been taken more than twenty times with a large trocar, yet the vein is as supple as in the beginning.

The serum obtained from the horse above referred to had a preventive power above fifty thousand—that is to say, a guinea

* Tuberculin is a sterilized and filtered solution, in glycerin, of a culture of the tubercle bacillus, and mallein a similar preparation of the glanders bacillus.

pig was unharmed by an inoculation of half a cubic centimetre (fifteen drops) of a recent virulent culture of diphtheria bacillus if it was injected one hour before with a quantity of serum equal to one fifty-thousandth part of its weight. If this antidiphtheritic serum is mixed with diphtheritic toxine, either in a test-tube or before injection into the organism, the toxine is rendered harmless.

The serum is obtained by abstracting blood from the jugular vein of the horse by means of a small hollow needle. All the instruments employed are carefully sterilized and kept in a five-per-cent solution of carbolic acid until they are used. The blood is received in wide-mouthed bottles, holding about two quarts, that have paper tied over the mouths, and that have been carefully sterilized. The horse is blindfolded, its extremities fastened to prevent struggling, a noose is passed around its upper lip, the neck is then made tense, the hair clipped from the skin where the hollow needle is to be introduced, and the entire locality thoroughly scrubbed with a five-per-cent carbolic-acid solution. A small incision is then made through the skin of the neck, and the needle, with the point directed downward, is passed into the jugular vein; a tube connected with the needle is pushed through the paper covering the bottle, and from one and a half to two gallons of blood are withdrawn. The blood is allowed to coagulate and the bottles are placed in an ice chest, where they remain until the serum, amounting to from five to six pints, has separated from the other constituents of the blood. In twenty-four hours, as a rule, the serum is withdrawn from the bottles by means of peculiarly shaped tubes devised by Pasteur, and it is transferred to a flask containing a small piece of camphor that is intended to preserve it.

The serum may be filtered through a porcelain filter if there is reason to believe it was contaminated during its withdrawal, or if it is desired to keep it for some time. As at present prepared the serum has a tendency to lose its remedial influence after it has been kept for a time, and especially if it has been exposed to variations in temperature or to light.

Numerous experiments on animals inoculated with virulent cultures of diphtheria bacilli showed that the quantity of serum necessary to save life varied according to weight, to dose of toxine, to quality of toxine, and to the time of intervention. The serum is preservative and therapeutic, not only when opposed to the toxine but also against the living virus. Roux has frankly acknowledged that these properties of antidiphtheritic serum were discovered by Behring, and upon them depends the serum treatment of diphtheria. The specific action of the serum depends upon a complex substance known as "antitoxine."

An animal injected with the antidiphtheritic serum becomes refractory to diphtheria almost immediately; but the immunity does not last, as it diminishes from time to time, disappearing in some days or weeks according to the strength and the quantity of the serum administered.

To give an idea of the strength of the serum used in his experiments on children and animals, Roux stated that one tenth of a cubic centimetre, about a drop and a half, of the toxine he employed would kill a guinea pig weighing five hundred grammes, or one pound, in forty-eight hours; but a mixture of one tenth of a cubic centimetre of this serum with nine tenths of a cubic centimetre of those toxines did not even cause a local effect in the guinea pig that received it. In other words, a dose of toxine that would suffice to kill nine average guinea pigs was rendered inert by one ninth of its quantity of serum. Experiments on animals have shown that where the toxine is introduced first it is necessary to give more of the serum, and after a certain delay the serum exercises no antagonistic effect on the toxine that was administered.

The preceding facts have served to bring us to the consideration of the use of the serum in the treatment of diphtheria. The prevalence of the latter disease may be judged from the reports of the United States census of 1880 and of 1890, the statistics of the former year showing that diphtheria and croup caused 77·96 deaths per thousand deaths, and those of the latter year showing that they caused 49·54 deaths per thousand deaths. This experience of a lessening of the mortality from diphtheria has not been confirmed by the statistics of New York city, in which there was a rise and fall from 1883 to 1892 inclusive:

Mortality per Thousand of Deaths.

1883	48·60	1888	63·54
1884	52·46	1889	59·55
1885	61·09	1890	44·46
1886	72·15	1891	45·12
1887	78·49	1892	47·55

In fact, it may be noticed that the year the census statistics were obtained the mortality in the city of New York was less than in any other year of the series. This oscillation has occurred in other countries. Thus, in England, during the decade 1861 to 1870 the diphtheria mortality was one hundred and eighty-seven per million living; during the decade 1871 to 1880 it fell to one hundred and twenty-one per million living; while from 1881 to 1890 it increased to one hundred and fifty-nine per million; and this increase was the more conspicuous because both the general death-rate and the death-rate from infectious diseases had been

constantly diminishing during the three decades mentioned. With this evident increase in diphtheria mortality—an increase that is the more noticeable when the general activity in sanitation during recent years is recalled—the necessity for some remedial agent is apparent. Like epidemics of other infectious diseases, diphtheria epidemics show various characters; sometimes being very mild, sometimes very severe, with a high death-rate. This variation seems to be due to differences in the number and virulence of the bacilli, the result of unknown causes, to the association of other bacteria with the Klebs-Loeffler bacillus, and to unrecognized individual tendencies.

The serum treatment of diphtheria is being generally tried throughout Europe and America, and the evidence seems conclusive that it is of benefit. In a series of almost fifteen hundred cases of diphtheria that has been collated from the reports of a number of observers, treated by antitoxine serum, the mortality averaged 22·99 per cent, the maximum being 44·9, the minimum 5·5 per cent. This in itself is striking, for the usual diphtheria mortality is over 50 per cent. Roux, Martin, and Chaillon reported four hundrsd and forty-eight cases treated in the Paris Hospital for Children's Diseases, from February 1 to July 24, 1894, with a mortality of 24·33, while during the same time five hundred cases of diphtheria were treated in the usual manner at the Trousseau Hospital in the same city, and the mortality was 63·2 per cent. W. Koerte reported one hundred and twenty-one cases treated in the Berlin Urban Hospital between January 20 and October 27, 1894, with the serum, in which there was a mortality of 33·1 per cent, while of one hundred and six cases treated during a period of that time without the serum—none being obtainable—53·8 per cent died.

The injection, which is administered slowly in quantities of twenty cubic centimetres (a little more than five drachms) beneath the skin of the flank, is not painful; and if it is made antiseptically, no ill effect follows, and the dose is absorbed within an hour. In twenty-four hours a second injection of from ten to twenty cubic centimetres may be given, and the two injections ordinarily suffice to cure. The temperature usually falls after the injection, although in grave cases the fever may persist. The pulse becomes normal more promptly than the temperature.

The general condition remains good, as a rule; and the false membranes usually cease growing after the first injection, becoming detached within seventy-two hours. Roux gave a child a thousandth part of its weight in serum, though in severe cases he increased the quantity to a hundredth part of the weight. The treatment should be instituted as soon as possible after the infection, as those children treated with serum on the first or sec-

ond day of infection have all recovered. While the experiments on animals showed that injections of the serum did not exercise a permanent influence in immunizing the animal, there can be no doubt that such injections would exercise a prophylactic effect if administered to those that have been exposed to diphtheria.

One of the great obstacles to the general employment of the serum is the cost of its manufacture. In this country from five to ten dollars is asked for a small quantity that sells on the continent of Europe for not more than one fourth of those sums. The British Institute for Preventive Medicine finds that the serum for a single case costs, to be manufactured, from fifteen to twenty-five cents. Public subscriptions have been started in various large cities in the world for the purpose of securing funds to establish and maintain laboratories for the manufacture of the serum. Roux estimated that for a population such as Paris has (two millions and a half) a serum laboratory would require twenty horses, three grooms, two bacteriologists, and two laboratory assistants, bringing the expenses of maintenance to eight thousand dollars a year, a sum that would be insufficient in this country, where the salaries, etc., would have to be so much higher.

From what has been said it may be deduced that the production of antitoxine serum is a matter of time, that it must be made with the greatest care, and that each lot must be tested to determine the degree of its antitoxic power. Only by such tests can its efficiency be determined, for there is nothing in the gross appearance of the yellowish fluid to indicate whether it will or will not exercise therapeutic influence. As no other remedy should be employed in conjunction with it, the dire results to the patient of administering a worthless serum may be appreciated. The Board of Health of New York has found specimens of serum, alleged to be antitoxic, exposed for sale, bacteriological tests of which demonstrated its worthlessness. This can only be prevented by the enactment of State laws that punish by heavy fine the sale of, or allow the recovery of heavy penalties for the administration of, any antitoxic serum that is not approved by the State Board of Health. The importance of exercising such control is appreciated abroad, where, in France, a bill is in preparation for introduction in the Chambers providing that no antidiphtheritic serum but that prepared under Roux's observation, or tested in his laboratory and found equal in curative influence to that prepared by him, shall be sold or administered. In Italy no antidiphtheritic serum but that prepared by Roux, Behring, or Aronson is admitted into the country. A good antidiphtheritic serum is not only harmless but is a remedial agent; a poor or spurious serum may be poisonous in itself as well as being worthless for controlling the disease.

Our present knowledge of diphtheria depends upon the discovery of its specific microbe by Klebs and Loeffler, on the proof that this micro-organism causes diptheria, on the isolation of the diphtheria toxine by Roux and Yersin, and on the discovery of the antitoxine by Behring. An immense field of research spreads out before us; for example, all but the last-mentioned fact is as true of typhoid fever as of diphtheria, and it is probably a matter of but a few months when physicians will be at work determining the scope of usefulness of a typhoid antitoxine.

WINDMILLS AND METEOROLOGY.

By P. J. DE RIDDER.

THE credit that has been given in all ages to the spirit of observation of sailors is only justice. There are other observers, however, no less sagacious and no less assiduous than sailors, whose powers have not been so conspicuously published. These are the millers of windmills. The number of these observers is necessarily diminishing rapidly in our days in consequence of the progressive disappearance of windmills before the advance of steam mills. Yet there are still in the lands of Holland and Flanders a considerable number of these old-fashioned millers, and it has occurred to me to give a few lines to the consideration of the way in which they observe the phenomena of the atmosphere.

They are real observers, as we shall show. The most intelligent of them observe, according to their own rules, all the changes of the weather. Those of a lesser degree of intelligence are satisfied with noticing the movements of the mills situated farthest in the direction whence the wind comes, and thus regulating the management of their own mills after the example set them by their fellows. These prepossessions of millers concerning the weather should not surprise us, for it is in the line of their direct interest to prognosticate atmospheric changes, and especially to be able to foresee how strong the wind will be, as much for the safety of their mills, which are exposed to all the storms, as in view of keeping on good terms with their customers by properly executing their orders.

So, after a considerable duration of calm weather, the miller, seeing the cirrus and the cirro-stratus appearing in the south-western horizon, joyfully exclaims:

"To-morrow the wind will blow
And the mill will turn."

Modern meteorology was still in an embryological stage when the millers had attributed their true signification to the cirro-stratus clouds which stretched out in long, narrow bands, sometimes from the horizon to the zenith. They called them "wind trees." They were as well acquainted with the cirro-cumulus, the alto-stratus, and the cumulus. Proof of this is found in the enigmatical and obscure language of an old miller who declared he had seen in the sky "a shepherd under the shadow of a tree while the sheep were pasturing in the field."

Besides looking into the nature and meaning of the cirrus and the cirro-cumulus, the miller tried to calculate the force of the wind in distant storms; he observed the direction and velocity of the lower clouds; he estimated at sight the volume and density of the storm clouds; and if the wind fell off before the rain came, he recollected the old saying, "A calm comes before a storm."

He especially displays extraordinary vigilance in times of heavy showers. He observes, among other things, if the mills farthest away in the direction of the rain have kept their sails unfolded; if they have, it is a good sign. He scrutinizes the sky at every moment, from the zenith to the horizon; he measures the curvature of the forward part of the precipitation or of the storm. The lines of rain or hail that escape from it show him by their length and their approach to the perpendicular how intense the precipitations are. If the lines run obliquely, he is shown the direction of the dominant wind in the squall—in short, no sign indicating the force and direction of the wind passes unperceived by him. He knows likewise that these showers are often accompanied by tempestuous, plunging gusts which seem to come out of the clouds; and frequently, before the most advanced flecks of the storm cloud have reached the zenith, the sails of the mill are rolled up around the arms so as to give the squall free passage.

Except by meteorologists, it is still not generally known that the air is urged on more violently on the right of the squall than on the left; but the old miller knew it long ago by experience. The storms that passed by on his left, from west-by-southwest to south, never gave him any fear, and he confidently left his sails all unfurled in the wind; but whenever he was directly threatened with a storm which would pass over his zenith, or which was coming from the right—that is, from north-by-northeast to east, at a distance of less than five kilometres—he foresaw the possibility of a strong blow, and took his measures accordingly. I never knew of a miller who could account for the squalls from his left being less formidable than those from his right. The explanation of the phenomenon was reserved for modern meteorology,

which has taught us that squalls and thundershowers constitute depressions in miniature, or at least weak secondary depressions dependent upon a principal depression and formed under its immediate influence.

The old miller, an observer by virtue of his profession and then an observer by the force of circumstances, was obliged to study the wind in all its manifestations of direction and force; he was thus aware that its maximum velocity corresponded with the maximum temperature of the day. Although this rule is not without exceptions, the miller was rarely mistaken. Proof of this is given in the habitual and reassuring response to the farmers who came to the mill in the afternoon, when the wind had fallen so low that no grinding could be done:

> "Come to-morrow noon again,
> And then I will grind your grain."

Everyday observation has taught us that things really go thus when the wind originates under anticyclonic conditions; in the opposite case, if the wind rises in the evening and gains force during the night, the meteorologist concludes that its origin is cyclonic, and a change of weather is probable.—*Translated for The Popular Science Monthly from Ciel et Terre.*

In a paper on the Inheritance of Acquired Characters, Prof. A. S. Packard assumes that "all progress in humanity appears to be due, not only to our maintaining the present intellectual environment, with the manifold and many-sided stimuli of our present social structure, but also to the unceasing efforts of the leaders in advanced thought in many different departments of training and effort to open up new fields of research in natural, physical, and mental science and their applications, to gain new and higher points of view in sociology and morals as well as in statecraft, and, in short, to perfect and hasten the development of the ideal man. Unless this progress, which is a historical fact, has been due, not only at the outset, but all through human history thus far, to this principle of the inheritance of mental traits, causing the intellectual efforts of one generation to pass down and thus to have finally a cumulative effect, how could there be any progress in human society? On the one hand, let us imagine a cessation of the operation of this principle. Suppose all the forces and stimuli of modern society to be removed, and the human organism to live like blind beetles in a cave, or a savage tribe isolated in the midst of an otherwise uninhabited continent, with a total uniformity of conditions, physical, social, and moral, the effects of disuse would at once set in. Heredity without this vivifying principle of cumulative transmission, as it might be called, would be retrogressive in its action, and the race would by reversion return to the status of prehistoric times. Or, on the other hand, if the present intellectual environment were maintained without the cumulative action of the principle of inheritance of acquired characters, the social organism would become stagnant, and the race would be semi-fossilized, or in a state of arrested development, like the Chinese."

BRAIN DEVELOPMENT AS RELATED TO EVOLUTION.*

By Hon. G. HILTON SCRIBNER.

I.

NO subject in recent times has received so much attention, or been so carefully investigated, as the question of the origin and age of man. Even that large class of scholars who long since came to regard the development of man from lower forms as a closed question have persistently held that it would be extremely desirable to ascertain the full extent to which visible and indisputable evidences could be discovered and authenticated, bearing upon this particular issue of the antiquity of man in the developed form we now call a human being. And it is safe to add that no investigations have ever been carried forward with more circumspection on the one side, or under the fire of a more searching and severe criticism on the other. For this question, involving the origin, and age of man as such, constitutes the very pith and animus of the captious contention still going on as to the soundness of what is commonly called, in a broader sense, the doctrine of evolution.

If the theory of the gradual unfolding of all other organic life could possibly have been accepted without disturbing the belief in the recent and exceptional origin of man, it doubtless would have long since received the approval of all intelligent minds.

It is because man, the head and consummation of all animate existence on the globe, is drawn into the restless current of all common and lower life, although in the van yet as part and parcel, kith and kin of it, that the whole theory of evolution is at first thought and to many minds fearful and shocking. Therefore the arguments and the objections constantly hurled against the broad conception of evolutionary descent involving man are legion, and this theory could never have held its ground against such an assault but for the one controlling fact that, fortunately or unfortunately, it is true. It is so true that, like a principle in morals, or the philosophy and spirit of Christianity, or a logical sequence, or a theorem in mathematics, when once understood, it compels belief.

Its critics, therefore, from whose ranks nearly all converts to the theory have been made, regarding the antiquity and origin of man as its most objectionable feature, have very naturally and from the first attempted to discredit all evidences of his prehistoric existence.

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* Read before the Fortnightly Club for the Study of Anthropology, of Yonkers, N. Y., February 16, 1893, by G. Hilton Scribner, president.

For instance, the reality and authenticity of the "human remains and works found in the Danish shell mounds and peat mosses, in the lake dwellings, in the coral reefs of Florida, in the cromlechs, barrows, and kistvaens, and in the rock shelters," were at first disputed, and when fully established by repeated discoveries it was then claimed that they all fell within the historic period. This contention was, however, quickly overshadowed and swept away by the more recent and numerous discoveries of stone implements, carvings, and human remains found in England, France, Belgium, Sicily, and America.

"Many of these discoveries were made in the valley of the Somme, the caves of the Dordogne, the valley of the Ouse, the basin of the Seine, the valley of the Thames; in the clay of the Hoxne, in the gravel of Icklingham, in the caves of Engis, Engihoul, and Neanderthal; in the cavern of Wells, in the caves of Gower in Glamorganshire, in the Grotto di Maccaquone in Sicily"; in the aqua-glacial deposits of the Delaware, of southern Ohio, of Mississippi, in Minnesota, and also in the old river bed under Table Mountain in California, and in many other localities, carrying back, in some instances, the age of man as a human being probably to the first or great Glacial period, and certainly to the beginning of the Quaternary, "for many of these remains are found intermingled with the bones of that large class of extinct animals which passed away with the telluric conditions to which these animals were organically related."

Now, since the almost immeasurable antiquity of man, as such, has been thus shown and placed beyond reasonable doubt, a new and popular objection has come to the front which brings us face to face with the subject in hand.

It is claimed by an immense number of people who are but slightly acquainted with the subject in its broadest significance, that the cranial capacity of these early men is found to be nearly equal to that of modern savages; that the cranial capacity of the modern savage is nearly equal to that of the average routine laborer among the civilized of to-day; and that these facts are inconsistent with the alleged progressive and developing character of man structurally and organically. And it is also urged that these discoveries really show affirmatively that man, as a human being, has always been mentally, structurally, and organically just what he is now, at least as far back as we have been able, with all our research, to trace him.

Now, these objections merged in one are, as we have stated, based upon an alleged comparative uniformity, or nearly equal cranial capacity, at present and during all the past ages, whenever and wherever man has been revealed.

This objection is what it appears to be, a random shot, or a

convenient expedient, resorted to by that large class of persons who have made no exhaustive examination of the subject; but, baseless as it is in fact, it has about it a certain degree of plausibility not common with its predecessors. Moreover, as it is probably the last objection possible in the premises, it is better to deal with it patiently and set it aside carefully and becomingly.

It is not quite true that the cranial capacity of these ancient and primitive men has been shown to be nearly equal to that of modern savages, but, not to split hairs, let it pass that it is so, for a comparison of the cranial capacity of the savage and civilized races now existing, and an explanation of their relations in this respect, can be more accurately made, and it may be assumed that no one will be found to deny that a great change of some sort has taken place which is synonymous with what is commonly called the rise from savage to civilized life, even though the cranial capacity of the two classes should be held to be nearly equal—which, however, is not, as a rule, the case; at any rate, the two questions thus presented are as exactly alike as are two equilateral triangles, and so the former is fully answered by making a satisfactory disposition of the latter.

If we first consider, then, the difference in cranial capacity between the lowest savages and the highest civilized men, we shall at least know that all other cases will fall within the limits of this comparison. For this purpose perhaps no better or more reliable information can be found than that furnished by the exhaustive and well-known investigation made by John R. Marshall, F. R. S., Surgeon to University College, London, and reported in the Transactions of the Royal Society as early as 1864, and thus before the question we are examining became important. The entire report is very lengthy, extending to the minutest details.

The subject was an average Bushwoman, selected and sent him on request from southern Africa. She was about fifty years of age and five feet in height. Her brain weighed thirty-one ounces, while that of an average European woman of the same age and height would weigh forty ounces. The ratio of the Bushwoman's brain weight to her entire weight was as one to forty-five, while that of an average Europeon woman of the same age and height would be as one to thirty-seven. Let us now look at the extremes. The cranial capacity of the Bushwoman was sixty-one cubic inches, while the largest cranial capacity known in America is that reported by Morton, of Philadelphia, as being one hundred and fourteen cubic inches, and the largest in Europe is that reported by Wagner, of Germany, as one hundred and fifteen cubic inches. Still, this Bushwoman had a generous cranial capacity considering her race, for the average negro has but from sixty-one to sixty-nine cubic inches—the former being

her exact capacity. The Malay, although much higher in intelligence, has a still less cranial capacity, being only from fifty-seven to sixty-two, thus showing at the largest but one cubic inch in excess of that of the Bushwoman, and at the lowest, four cubic inches below hers. The Hottentots, but a shade if any higher in intelligence, have the large comparative average of seventy-five, or fourteen cubic inches more than the Bushwoman; while the Hindu, with all his arts and sciences, his literature, castes, complex government, and great book religions dating back to the very dawn of the historic period, has a less cranial capacity than the Malay, the negro, or the Hottentot, and it has been found in some normal instances as low as forty-six cubic inches. Is it not clear, then, that cranial capacity alone is not an infallible index of mental capacity or intelligence?

But Mr. Marshall found other and more important conditions in which the Bushwoman was exceedingly low down, notwithstanding her comparatively ample cranial capacity.

Let us quote his own words: "The convolutions are remarkably simple. The extreme curved convolution forming the outer border of the frontal lobe consists of three short, simple, curved branches, very like those found in the ape, instead of the tortuous sulci seen in the European brain. The forms of the surrounding orbital convolutions themselves, including the supra-orbital, are so broad and simple that the subordinate divisions which are so complex in the European brain can hardly be said to exist. All four of the primary convolutions are present, but all are characteristically short, narrow, and simple, instead of being complex and occupying a large space, but the arrangement is normal. They are evidences of structural inferiority, and show an infantile or even fœtal leaning." Having regard to the sum of its convolutional characters, judged by their presence or absence, their individual and relative size and position, their comparative simplicity or complexity, and the symmetry or asymmetry of particular fissures and convolutions, there is after all, Mr. Marshall concludes, a greater difference between the Bushwoman's brain and that of the highest apes yet described than between it and the European brain, but not so great a difference as exists between the brain of the orang and that of the chimpanzee, or between the brains of many other species of quadrumana.

Here we have two very interesting and important facts disclosed, which have been substantiated by many other similar investigations, of which this recital is but an example. First, that cranial capacity is not the main factor in determining intellectual and emotional development, but that increased brain surface, or the extent, number, variety, and depth of convolutions by

which the brain surface is increased, do furnish a better index. Second, that this physical co-ordination with increased mental and emotional activity, this physical manifestation of developing mind, has already taken place in the brains of apes, and is foreshadowed in the lower species of quadrumana.* Furthermore, from an intelligent standpoint this is precisely what might have been expected.

Let us bear in mind that out of all the innumerable, almost infinite number of variations, eccentricities, and oddities, however slight, found by examining each individual microscopically (if such a thing were possible), those minute changes and peculiarities, and those only, will be preserved in the long run, and after many generations, which are of such a character as to secure for their possessors more vigor and longevity than those without them can possibly have, simply because vigor and longevity vastly increase the opportunities of heredity.

Now the size and weight of the brain in proportion to the size and weight of the body is just one of those important proportions of parts which would make for or against the vigor and long life of the individual in a marked degree. One other concurrent condition, however, would perhaps be of even greater importance, and it is this: that the height, size, form, and weight of the whole body should have the fittest adaptation to its circumstances and to the work required of it, in order to secure the greatest vigor and longest life, and so at last to become the characteristic of every member of the species. So it is plain that the brain as to size and weight must stand two tests. It must not only bear the best possible proportion to the body, but that body must be of the fittest size and weight to meet successfully, and for the longest period, all that it is compelled to encounter, and thus to succeed above all other less fortunate individuals in finally making this double due proportion the property and the universal characteristic of the species. Within these limitations and conditions, but not otherwise, the size and weight of the brain and consequent cranial capacity are doubtless subject to the amount of mental instinctive, receptive and emotional activity demanded of it, and carried on within it. In shorter phrase,

* Functions of the Brain, by David Ferrier, M. D., F. R. S., Professor of Forensic Medicine, King's College, London, published by Smith, Elder & Co., 51 Waterloo Place, London, p. 297: "The brain of man is constructed on the same type as that of the monkey, and essentially the same primary fissures and convolutions are recognizable in both, the chief differences consisting in the greater complexity of the convolutional arrangement of the human brain, caused by the development of the numerous secondary and tertiary gyri, which tend to obscure the simple type of the simian brain. These differences are more marked in the adult and highly developed brain, but are less pronounced in the fœtal human brain." See, also, Ecker on the Convolutions of the Human Brain, translated by Galton, etc.

the brain may grow with increased exercise and larger and more frequent demands upon it like any other organ up to the point of becoming out of due proportion to the body, but still, the individuals possessing brains which exceed this limit would necessarily labor under such a disadvantage, as entire organisms, that they would in time be eliminated from the species. Now these are not simple deductive conclusions, as we shall soon see.

We have now cleared the ground for a statement of the actual sequential physical development accompanying increased mental activity after the head has attained such size that the cranial capacity can not be further enlarged without serious disadvantage to the individual. It is well known that the exterior surfaces of the brains of the lower vertebrates have, as a rule, comparatively smoother surfaces where they come in contact with the cranium, showing that the capacity of such heads as are in best proportion to their bodies is quite sufficient (without any such convolutional development as we find in the case of man) for all the mental and emotional activity and brain work demanded in the lives they lead.

But there are other animals that have thumbs opposed to four fingers like our own, and they can use these hands as we use ours, they can pick up stones and sticks, fruits, seeds, and nuts, catch insects, break branches and throw them down; they can pick and pull things in pieces, examine, inspect, and experiment with them, and reach conclusions (such as they are) about almost everything with which they come in contact. They can also unite their strength and their ingenuity, and can thus render services to each other. All this naturally multiplies their needs, and much more their desires, renders the exigencies of their daily experience more frequent and important, and their lives more diversified and complex. Thus the mental and emotional activities of all the quadrumana are so much increased by the use of a thumb and fingers that a head which is in due proportion to a body such as would be best adapted to springing, climbing, jumping, swinging, and other arboreal habits requiring great activity and expertness, has not sufficient cranial capacity for a brain with so much mental and emotional work to do. Here, then, we find for the first time a variation which characterizes more or less the whole family of quadrumana according to the degrees of intelligence of the several species. It consists of slight corrugations on the exterior of the brain, thus increasing the superficial area for the gray matter, without enlarging the head, the brain weight, or the cranial capacity to their disadvantage in other respects.

In the case of anthropoid apes, and proportioned to their greater intelligence, these corrugations or convolutions are increased in number. In the case of the lowest savage there is still

another increase in number, variety, and depth, as we have seen in the case of the Bushwoman. And thus these convolutions go on *pari passu* with increasing manual dexterity and intelligence, multiplying, assuming more varied and complex forms and greater depth, until we reach the most thoughtful and learned members of the highest civilized communities, where the brain surface if smoothed out would measure, on an average, about four square feet.

What immediately concerns us, however, in this connection, is the fact that not only the savage and the primitive man, but the ape and even certain quadrumana, have already found more contriving, thinking, remembering, and other kinds of brain work to do than a head and cranial capacity in due proportion to their bodies will admit of. And thus each and all are preserving and perpetuating by natural selection and heredity all the variations of increased cerebral surface resulting from more numerous, varied, and deeper convolutions.

Is it inconsistent, then, with the theory of evolutionary descent for the savage to have the largest possible cranial capacity and head not out of due and advantageous proportion to his body and the demands of his mode of life? This question is completely answered by the fact, which has now been fully set forth, that the further growth of head and consequent cranial capacity in his case has been already arrested, as in the case of the ape and the quadrumana, at the point of becoming too large for his body and mode of life, while his still increasing and developing mental and emotional powers and activities have already found a substitute for further cranial capacity, or head growth, in more numerous, complex, and deeper convolutions, thus increasing the brain surface.

It is surprising that this objection has not been earlier demurred to on the specific ground of inadequacy. It now appears that as well might the cranial capacity of an ape as that of a savage or a primitive man be made the basis of this objection, since in all three cases further head growth has been checked at the point of undue proportion to the body, and thereafter increasing mental activity has found a physical substitute for further head or brain growth in the preservation, as a fitter adaptation, of every fortuitous variation in the direction of these increased convolutions, first foreshadowed in the quadrumana, reaching the highest complexity in civilized man, and co-ordinated to advancing intelligence at every intermediate step.

Thus we see that this popular objection crumbles at the first touch of a few simple and well-known facts.

II.

We have now reached a position where we may compare with more interest than before the mental activities of the savage with those of the routine laborer in civilized life, and thus show inductively that the conclusions adopted are sustained by an applied and practical test.

We are all equally well qualified probably to form an estimate of the degree of emotional intensity and mental strain exercised in making again and again for a lifetime the same one single thing—for instance, a pair of shoes or trousers or a coat; in doing mason, painting, or plumbing work; in constructing furniture, shoeing horses, or setting type; in putting bobbins into and taking them from a machine in a factory, or in running the machine itself by switching on and off the belt; or in running the engine which propels the machine, or even in running a lathe which carves out over and over again the same part of some machine or implement; or in planting, harvesting, mowing, or chopping, or any other kind of routine work which is learned by imitation and thereafter performed automatically. Of course, the case was different when the same man, as formerly, had to perform nearly all the above kinds of labor for himself.

It is safe to say, however, since the recent extreme division of labor, that a month of any one kind of such work would not give rise to as many exciting incidents or unexpected exigencies stirring the emotions and requiring sagacity, mental alertness, quick perceptions, rapid decisions, and skillful execution, as would be encountered in a successful attempt to catch a squirrel, kill a deer, or fight a wild cat with savage appliances.

Flippant and superficial as such a comparison may seem, at first blush, in a serious paper, it is, however, quite necessary to illuminate, as no other method of presentation would do, the almost immeasurable difference between all the vocations of the savage and those of the routine laborer in our civilized life. To get a living, the hunting savage of the stone age is obliged to go through these wildly exciting experiences and vicissitudes, no two of which are exactly alike, nearly every day of his life, and frequently several times a day. It is, moreover, the exciting nature of primitive pursuits which makes this everyday labor of the savage a lively and interesting recreation for the most cultured and intellectually advanced classes among the civilized.

Now this wide and extreme dissimilarity arising from the very nature of savage pursuits, when compared with those of the routine laborer, uncovers to our view a far-reaching cause in development of which careful note should be taken.

The savage, as we might even now imagine, and a little later

on shall more fully see, has a brain which is insufficient for his mode of life, and it is therefore constantly overtaxed by the amount of mental and emotional activity required of it. This, too, is the one antecedent condition and primal cause underlying, lifting, and advancing not only his but all human brain development, and probably all brain development.

Here we must leave for a time the savage and consider the present condition of the routine laborer.

He, on the other hand, has more cranial capacity, and convolutional development than he needs or knows what to do with. Two great changes have recently come over the whole civilized world, and among many other far-reaching effects these two changes have left him in this unfortunate condition. In the first place, machinery has taken the place of implements, and the latent energy of lifeless matter has been transformed into kinetic force and has taken the place of muscular power. The greater and constantly increasing part of his food is sown by machinery, cultivated by machinery, harvested, thrashed, transported, ground, cooked, and brought to his door by machinery. He is clothed, sheltered, and shod by machinery. His house, except the putting of it together, is made by machinery. The water of a distant lake or stream is brought through pipes to his very lips by machinery. His furniture, utensils, and tools are all made by machinery. His distant communications are conveyed by machinery. He himself is transported about from place to place by machinery. His cradle and his coffin are made by machinery, and from the time he leaves the one till he enters the other he is lucky if he finds any more soul-stirring or intellectual employment than feeding, watering, shining up, waiting upon, and serving a machine.

The second great change is of a social character, but it has been greatly hastened and extended as a result of the first. At any rate, the two, each supplementing the other, have left his inherited cerebral outfit almost wholly unemployed, as compared with its busy activity at a time not very remote, even in the age of our grandfathers, when, like the savage, the worker cared for himself and his family and did nearly everything for himself, instead of doing possibly, as at present, some one thing for himself, and having all else done for him.

His children now receive a rudimentary education in public institutions, their moral and religious instruction is received in the free Sunday school; hospitals, dispensaries, and doctors take care of him when ill, and charitable societies take charge of him when he comes to want; savings banks receive his money and manage his investments; insurance companies relieve him from the calamities of fire and flood, accidents, illness, and death; public

health officers sniff through his dwelling and order its sanitary conditions; public overseers of buildings supervise its construction, and are required to serve notice on him when it is likely to tumble down and hurt him; the police protect his person and his property, and the courts settle his disputes; he is examined, vaccinated, and protected from contagious diseases at public expense; the overseers of the poor help him in unexpected exigencies; public baths are provided for his use, and public soup houses are opened for him in time of general depression; temperance societies try to help him control his appetite; salvation armies endeavor to restrain his vices and improve his habits; trades unions tell him when he may and may not work, what work he may do and who he may work with, how much he may do in one day when he does work, within how many hours of that day he will be permitted to do it, and who he may or may not work for, and the least price he will be permitted to receive for his labor; the churches all assist him in his spiritual and religious life, and the largest and oldest of them all will engage, for a small weekly pittance and a few formal observances on his part, to safely deliver in paradise at last what little soul a man may have left after such a life as this. Thus all the complex cerebral and convolutional development in his case, which it has taken perhaps some hundreds of centuries to build up, is rendered comparatively superfluous and, to the same extent like all unexercised and useless organs or parts of organs positively detrimental and so to be modified or got rid of, and all brought about by these two great changes, we brag of (and with good reason from other points of view), both of which changes have taken place within the last two centuries, chiefly within the last hundred years, and the most important features of each within our own lifetime.

It is possible, of course, that some unforeseen change may occur, and it may bring with it some new and unexpected field for the exercise of his former mental activity, but at present it is neither apparent nor probable. Thus the routine laborers, constituting a large proportion of the inhabitants in many civilized countries, most of whom have, or recently had, sufficient cerebral capacity for great mental activity, are left with little more need of, or exercise for a complex organ of thought in the performance of their actual work than a caged squirrel has in rotating his wheel, and outside of their actual work society in one form or another has taken almost complete charge of them and of all which formerly interested them. It is certain that with this continuing condition—despite all social and educational efforts to the contrary—the routine laborer must fall back through atrophy and degeneration to some plane where the equilibrium be-

tween his inherited cerebral capacity and the actual demand for mental activity shall be restored.

We have now only time left us to review briefly two or three of the many peculiarities of savage life which stimulate increasing mental activity and its physical manifestation in convolutional development, and which peculiarities do not to the same extent, if at all, affect civilized men, and especially the routine laborers among them. To do this exhaustively would require a volume, and we can therefore only glance at the matter in the most cursory manner.

It is an open question as to the extent that the use to which learning is to be put constitutes a factor in determining the value of the mental development received in acquiring such learning. To whichever school of thought one may incline, it can hardly be denied by either side that in the acquisition of the same knowledge by two persons, the one for one purpose and the other for an entirely different but equally important object, the strengthening and developing effect, other things being equal, would be the same. Now the common hunting savage of the neolithic age takes up one branch of the study of natural history and pursues it until he is able to teach an Agassiz, an Audubon, or a Darwin. Not one of these learned men knew, after a life of study and observation, as much about this one thing, the habits of the wild beasts, birds, and fishes, as does the average savage hunter. To him such knowledge means food and life, and the lack of it hunger and starvation. He must know their color, size, and movements; when, where, and how they get their food and water; where and how they make their nests or lairs or homes; when they rest and when they go forth, and where; all their cries and sounds, and the meaning of them; and he must be able to imitate them so exactly that they shall think these sounds made by one of their own kind; he must know when and where they are moved about by winter and summer, by drought and flood; when and where they breed their young, and in each case whether the young are protected by hiding, defense, or flight. He must know what animals have leaders or sentinels, and how to distinguish them, and how to interpret their sounds of alarm, and distinguish them from the sounds of safety, and he must be able to perfectly produce both; he must know their strength, alertness, and acuteness of sense, speed, and endurance as related to the species and to the age and sex of the individual; he must be familiar with their dispositions, their courage, cunning, intelligence, and timidity, and be able to determine in advance what they would probably do under all conceivable conditions. Then it is not less necessary that he should know all the relations of each species to each and all of the others. To acquire this

knowledge he must roam far and wide, and to do this with safety he must learn the physical geography and topography of the country; he must know the trend of the coast, the course of the rivers, the valleys, and the mountains, and the extent of the different water-sheds; he must discover the location and character of all the varieties of vegetation upon which animals feed; he must learn all their methods of capture and escape in all cases where they feed upon each other; he must become an expert in the study of all their tracks and the traces of their movements. The broken twig, the cropped grass, the grazed log, the pressed or upturned leaf must each reveal to him a whole series of facts in which a determination of the lapse of time is always most difficult; he must study the movements of the sun and moon and planets, and the position of the stars; he must learn to determine direction by the growth of mosses, the leaning of trees and the appearance of the foliage, and many other things equally important.

It is true that some part of this vast amount and variety of information may be communicated and so handed down from one generation to another, but the larger part must be acquired in the field and by each individual for himself. Much of it to be of practical use must be accompanied by the most wonderful skill and adroitness in its application. A practiced eye, an acute sense of hearing, deftness in movement, promptness in decision, coolness in execution are indispensable, and can not be taught orally or communicated. No civilized man could equal a savage hunter in this whole department of knowledge.

But comparisons of this sort are unsatisfactory to the last degree, because the probability of deriving a reasonable and fair conclusion from them depends more upon the ability of the mind to grasp and value details, to weigh justly many considerations, and to deal fairly and wisely with the facts, than it does upon the facts themselves. One thing is certain, however, that the savage would exercise the same amount of mental activity in obtaining all this knowledge for the purpose of getting a living by it, that a student of natural history would exercise in obtaining it for the purposes of a scientific classification. Moreover, the strength of motive, depth of desire, and intensity of emotion of the savage in his work would be as much greater than that of the student as it is more important to sustain life than it is to make a scientific classification; for the student, admitting that he works for bread or for fame or for gratification, may find many other ways if he fails in this to obtain either, while the savage must succeed in this one way or die in the attempt. Lastly, the savage obtains and applies his knowledge by the Baconian method of experience and experiment, while the student obtains his largely from books, and

the balance by observation, but the routine laborer does not rise to either method, relying on oral instruction and imitation for the little he needs or learns.

Let us now glance at another peculiarity of savage life. In all civilized communities, and under every form of government, the protection of the person, of life, and of property devolves upon a few members of society who from time to time are appointed or elected for that especial purpose. This, except in rare exigencies, relieves the individual from taking any direct measures for the defense of his rights. Indeed, he is forbidden as a rule to do so, but is required in case of assault or trespass to call to his aid those officers who have been selected to defend him. Neither may he make reclamation, obtain redress, or inflict punishment directly in his own behalf. The savage, on the other hand, contrives and maintains all of his own safeguards. All these things he invariably does for himself in obedience to the quickest and strongest of his instincts—that of self-preservation. Thus the civilized man is guarded, policed, and protected by others, while the savage is his own patrolman, judge, jury, and executioner. All the protective devices he needs, at any rate all he can have, he must contrive and enforce for himself. He is his own defender, detective, and avenger. This whole broad field of activity, therefore, which we call domestic police regulation, including also many other departments of the general government, the savage concentrates in himself and brings within the scope of his own mental, emotional, and physical activity.

It would be a mistake to conclude, however, from what has been said, that the savage enjoys a wider freedom by reason thereof than the man who lives on the avenue and pays taxes, or strolls in the park and reads the notice, "Keep off the grass." The savage has a government and laws in abundance, all founded on traditions, maxims, customs, signs, omens, religious superstitions, quasi canon law, and crude ecclesiastical usages, and the notions and whims of a despotic chief, which reach to every detail of life, but they are all mandatory and restrictive rather than protective in their purpose and character.

When we couple all this with the amount they must learn, the ingenuity they must exercise, and the exigencies they must encounter in wrenching even the most precarious livelihood from unreclaimed Nature, is it at all strange that their immature brains are overtaxed, and that every variation in convolutional development is preserved and perpetuated, especially after head growth and cranial capacity have been checked at the point of undue and disadvantageous proportion to the body?

Thus it appears, in view of all the facts which modern investigation has disclosed, the merest outlines of which have been here

given, that the comparatively equal head growth of all known men is no evidence whatever against the theory of their evolutionary descent, while the closely related fact that man shares with certain lower species of animals built like himself a brain development peculiar to him and them, and which has succeeded to an arrested head growth in his and their case alike, is more than an indication, it is very good proof so far as it goes that he and they had a similar if not the same origin and are members of the same family. And it is also evident, in the case of man at least, that this convolutional brain development is continuous from the lowest savages up to the age of machinery and the extreme division of labor, the accompanying institution of voluntary benevolent associations, and the modern forms of parental government, when it thus meets for the first time with a threatened reversal in the case of the routine laborer. He finds himself as a result of these changes in this predicament, he is still in possession, by inheritance, of the full brain development of the civilized, but with less use for, or need of it than has the hunting savage of the neolithic period.

In taking leave of this subject, one question not quite pertinent to the issue can not be repressed. Since all civilizations thus far have encountered a brood of incidental evils peculiarly their own, and, if not of their own creation, still consequent upon them, who can say that the one just exposed may not be the primal cause of the world-wide unrest of the present laboring classes, finding expression in all sorts of disorder from strikes to anarchy—the first fruits of atrophy—the vain attempt to employ an otherwise idle and already degenerating organ of thought, and, like all readjustments to a lower plane, resulting in vicious and reactionary conduct? If this result had been foreseen, could the cause have been suppressed? Is social growth, to any greater extent than individual, modified by desire and volition?

On the temperature of the surface of the huge extents of water of the oceans, Captain W. J. L. Wharton observes, the climates of the different parts of the world largely depend. Areas where great differences of surface temperature prevail are those in which storms are generated. In the region south of Nova Scotia and Newfoundland many of the storms which travel over the Atlantic have their rise. Here the variations are excessive, not only from the juxtaposition of the warm water of the Gulf Stream and the cold water of the arctic current flowing southward inside of it, but in the Gulf Stream itself, which is composed of streaks of warm and colder water, between which differences of as much as 20° Fahr. exist. The same conditions exist south of the Cape of Good Hope, another well-known birthplace of storms. Here the Agulhas current of about 70° Fahr., diverted by the land, pours into the mass of water to the northward, colder by some 25°, and the meeting place is known as being most tempestuous.

SYMBOLS.

By HELEN ZIMMERN.

THE progress made by the experimental school of anthropology in Italy is proved by the works which are appearing in rapid succession by such men as Lombroso, Ferri, Gorofalo, Cogliolo, Sighele, and Bianchi, to mention but a few. The study of criminality and degeneration has in these later years greatly modified the juridical canon, and that which once appeared monstrous heresy is now shown to be truth; nor, owing to the power of science, are the summary judgments any longer possible of which Dante wrote when describing Minos:

"Judges and sends according as he girds him."—(*Longfellow's translation.*)

Guglielmo Ferrero, author of a work entitled Symbols in their Relation to the History and Philosophy of Law and Sociology, also belongs to this school, being one of its youngest members. In order to introduce him to our readers it is enough to mention his collaboration with Cesare Lombroso in his great work, Criminal Woman (La Donna Delinquente), discussed in these pages, which was written as a companion to the Professor's former work, Criminal Man (L'Uomo Delinquente). Symbols is an accurate, minute, conscientious study of a phenomenon innate in humanity, and the volume appears opportunely at the present time, when fiction and dramatic literature are so often inspired by symbolism. On this account besides scientists, novelists, and dramatists are invited to make use of the book, above all in Italy, where, unfortunately, gentlemen of that kidney study but little and talk at random. Guglielmo Ferrero says in his preface: "This book is only an essay, only a rapid transit across an immense unexplored region of the history of mankind"; adding: "The moral miseries of man have been much studied; the many devious ways of the passions, love, hate, vanity, covetousness, have been explored; but his intellectual miseries have been studied but little, those wretched errors into which man falls by reason of the organic weaknesses of his intelligence, owing to which the paths of humanity up to the present day have been bathed so often in blood and tears."

Such the genesis of Ferrero's book; such its *raison d'être*, as I deduce from his own words: "If we reflect that accidental changes of name have generated ferocious rites, that for a question regarding statues or pictures blood ran in floods under the Byzantine Empire; that at this day, at any moment, Europe might blaze up with fires of war, provoked by some unlucky metaphor, or by an ill-expressed phrase exchanged on account of

some high political axiom: when we think of all this, who is it that can not see that beyond the ferment of the passions the most fatal enemies of man have been certain weaknesses and imperfections of his intelligence otherwise so highly developed?" A *raison d'être* therefore highly moral, and above all useful.

The volume is divided into two parts. The first deals with the physio-psychology of the symbol, the second with its psycho-sociological application. It is preceded by an introduction which treats of the laws of least resistance and of mental inertia, concerning which Ferrero holds views that are supported by Spencer, Letourneau, Garlanda, and other sociologists. It is beyond doubt a fact that man feels a natural repulsion for mental labor, and if there is one thing on earth that he dislikes it is work, even that of the muscles. In our author's words: "The Hebrew legend of Genesis causes God to give to man labor as a punishment for sin; a precious and ingenuous human document regarding the sentiments of primitive humanity toward activity. The love of savages for rest is for that matter so well known that it would be almost useless to dwell upon it at any length. It is sufficiently proved by the fact that almost universally the most fatiguing labors are reserved for women—that is to say, laid on the sex that were the first slaves, and which can not rebel owing to its weakness. In all savage communities the only male labor has been war and the chase; because war and the chase are associated with the pleasures of success—that is, those which arise from a consciousness of personal power, and the pleasures of vanity, through the esteem which surrounds, in primitive tribes, the strongest warrior or hunter."

Comparative etymology teaches that in Hebrew, in Latin, in Italian, and in French the word labor signifies pain or punishment. Man, by nature, avoids not only physical exertion but also mental, in that form which is known as attention. One constantly sees, "how practice precedes theory, and action is adapted to surrounding circumstances without the intervention of abstract thought."

How man acts under the influence of the law of the least effort Ferrero explains by the following example: "Another proof that man seeks to obtain results by the least possible effort is furnished to us by the growth of sociological evolution. Spencer has justly criticised with severity those scientific systems which see in every human institution, in the exact form in which we find it, the ultimate result of an effort on the part of mankind directed toward its creation. Man does not think as much as that; and no peoples have ever created their own institutions according to a finished plan, previously traced. Every social organism is the result, not of a complex idea, created by the

people at a given moment, but of the accumulation of many small inventions and ideas which each generation has brought as its contribution to the entire work. This may be clearly seen by the study of the genesis of social institutions. Ministries are at this day a very complex institution, and therefore were not created at one cast. What was their origin? In Egypt, the king's fan-bearer belonged to the military staff, and in time of war commanded a division of the army. In Assyria, the king's eunuchs acquired great political importance. They became the monarch's counselors in peace and his generals in war. In France, in the Merovingian period, the blacksmith and the chamberlain, who were personal servants of the king, became public functionaries. In England, in the most ancient times, the four great functionaries of state were the master of the robes, the superintendent of horses, the blacksmith, and the house steward. This shows that the position of minister was not deliberately created, but that when the king found, especially in military affairs, that his functions were too numerous, he delegated one to a servant. At first this could certainly have been merely a temporary expedient, which through the continuance of the conditions which led to it became definitive. From this first sketch arose, by successive small modifications, the whole political structure."

With other examples, and by close reasoning, the author closes his introduction by saying that "symbols also must be regarded as the unpremeditated result of a series of small inventions, each intended to satisfy some elementary need."

Ferrero then passes on to the main divisions of his essay. He treats first of symbols of proof, as he names them, dealing at length with the written document, so important to the transactions of modern civilization and yet so tardily produced, and for a long time so incomprehensible to the multitude. Ferrero describes the primitive symbols that existed to guarantee property, or to mark the right of conquest, and of contracts in general, particularly of matrimony, of parental authority, and of adoption. After a minute examination of their origin, he writes: "We see thus from these examples how symbols of this class have nothing mysterious about them. They are only our written documents, our citations, etc., in a less abstract and more simple and primitive form. To us, accustomed to the dry and bare juridical forms of our own time, these symbols make a singular impression, almost as of simple and ingenuous poetry; but we may be assured that those who practiced those acts found no more poetry in them than we find in our formalities. These symbols are characterized by the greater simplicity of the mental effort necessary to understand them, as compared with our own

formalities, and are therefore explicable by the law of least effort —the tendency, that is, of man to resolve the difficulties he encounters in the path of civilization by the methods which cost the least mental effort, accepting the most obvious solutions, and contenting himself with these until through the increase of his needs they become entirely inadequate to his requirements."

Ferrero then treats of descriptive symbols, enumerating them separately, and narrating how, from the primitive signs of recognition known to savages, we have arrived at the alphabetic writing, justly called by Ferrero "the most laborious and most complex of all the means of communication of use among men." And he is right, for writing is a most complicated association of optic sensations, acoustic images, and mental images and ideas. To read, we must be able to associate with the sight of a certain number of letters the images of certain sounds, drawing thus from graphic signs the acoustic image of the spoken word. We use these signs as spoken words, associating with them a given idea, a complexity of functions which is demonstrated also by physiology, because a particular nerve center is probably attached to the function of reading, as is shown by those persons who suffer from the malady called verbal blindness—that is, those who lose the sense of sight for graphic signs only, while they can see persons, houses, objects, etc., though they no longer recognize letters, either written or printed.

Symbols of survival, the hinges of the law, form the argument of another chapter. Born from the right of occupation and conquest, the epochs in which the *res nullius* abounded, they have come down to us, growing gradually, and forming in their turn those which regulate all the social movement of nations. Ferrero examines the analogies between these symbols in different nationalities, and concludes: "We have thus a fresh proof that man has never created institutions and customs, etc., according to a preconceived idea, and that his own determination counts for nothing in the ultimate results of his work. It was not the idea of contract or of pacific discussion which led to the substitution of purchase and judgment for rapine and the duel, but purchase and judgment substituted for rapine and the duel generated by slow suggestion the idea of contract and pacific discussion in the brain of man."

The sensations we experience of complex things are reduced sensations. Spencer also affirms this in his First Principles. The eye sees reduced images; the mind, by the theory of least effort, receives reduced sensations; and this phenomenon exerts a great influence upon the formation of symbols. For example, the reduplication which takes place in many languages in the formation of the plural, when it is the custom to repeat the substan-

tive twice, is seen also in the most ancient art of Greece, where on the bas-reliefs a forest was represented by one tree, an army by one soldier, a house by a single column.

Gradually symbols become more abstract and tend to lose their concrete character. "The consignment of a piece of sod taken from the ground in presence of the buyer and of witnesses is a concrete and material formality, almost a consignment of the earth itself; but the consignment of a bundle of straw as a sign of the sale of land or of a house is already a much more abstract symbol, because its visible connection with the thing is less, because the separation between the symbol and the thing is much greater, and man fills up the gap with the rich mental associations which are already formed in his mind. Another step, and the fragile straw too will disappear, and the material symbolism of primitive times be replaced by the more ideal forms of proof which we employ. So, little by little, almost unawares, man is brought by evolution face to face with the most complex abstract ideas."

Emotional symbols is the subject of an interesting division. Ferrero says: "We perceive that an emotion, produced by whatever cause, lasts for a certain time, then grows weaker until it is extinguished. Neither love, nor hatred, nor pleasure, nor pain are, fortunately for mankind, eternal, because, as they are also transformations of force, they cease when they have exhausted the initial quantity of energy which they possessed at their origin. We perceive also that by the law of mental inertia this emotion can not be repeated, even with reduced intensity, unless a sensation antecedently associated with the same emotion in experience excites or recalls it. Now emotional symbols are composed of those sensations which have the power to awaken dormant emotions; by the law of inertia they arise once more and reacquire their immense importance." Hence he proceeds to show how the trophy arose, and also how, from the custom of taking from the vanquished his most brilliant garments, splendid garments came to be the insignia of dominant and privileged classes, kings, princes, chiefs, to be held as tokens of authority. Ferrero makes a minute examination of the importance attached to dress in modern society, and proves how this is an excellent specimen of an emotional symbol. In support of his views he cites the words of Buckle, where he says that dress was of such importance in the sixteenth century that a person's condition was evident from his exterior, no one daring to usurp the habit of a superior class. But during the democratic movement which preceded the French Revolution the innovations of fashion were felt even in the reunions of good society. At dinners, suppers, and balls, as contemporary writers tell, dress had been so much simplified that

ranks were confused; ere long both sexes abandoned all distinctive garb, men went into society in "*frac*," women in simple bodies.

We now come to the most important chapter in Ferrero's work, that which treats of mystic symbols. It is a minute analysis of the genesis and development of these symbols, of their primordial and consequential causes, of their importance, and of the evil caused by their false interpretation. The series of mystic symbols is produced by the phenomenon which Ferrero calls ideatic arrest, and which he explains in the following way:

"We here find ourselves confronted by an ideatic arrest—that is to say, the series of mental associations by which we have arrived at a conclusion of causality becomes restricted to those facts which furnish an immediate sensation, and therefore leave in the brain images and ideas that have a tendency to associate themselves, and to exclude such facts as do not produce a special state of consciousness except through reflection; a laborious mental process, which ordinary men, and even thinkers in fields which are not their habitual objects of research, avoid, by the law of least effort." It is thus with writings, thus with books, with formulas mysterious to the vulgar, with commands, with prayers. By the phenomenon of emotional arrest in religion, nearly everywhere and at all times, the adoration which should lift itself up to God stops at the image which represents him. And Christianity, although inaugurated by Christ, the apostle of a spiritual religion, is at this day too often nothing else than a real idolatry, at least in the multitude. We cite Ferrero once more: "God is here confounded with his symbol; and the theory of emotional arrest explains such a confusion. No one has ever seen God, wherefore we can not have an image of him, unless we construct one ourselves by our own intelligence. Now, to construct mentally, without the aid of the senses, a graphic image, necessitates a considerable mental development. For this reason, even to-day, for nearly every person the word God corresponds in the consciousness only to a vague and nebulous image. Hence it comes that when the peasant sees the cross, which awakens in him a complexity of sentiments compounded of respect and terror, the idea or the image of God, through being a most indeterminate state of consciousness, associates itself weakly, or not at all, with his emotions. Wherefore there is at such times present to his consciousness only the sight of the symbol, the cross, and the sentiments relating to it, not the image of God; and therefore such sentiments can be directed only to the symbol, because that alone comes into the field of consciousness, and behind it there is not for the worshiper the image of God which it should represent. Now, as a symbol works only in so far as it has power to recall a

group of ideas and sentiments, if these associations do not come the symbol passes into the condition of reality, because the emotion is arrested by it and does not rise to what it represents. This is why idolatry is always repugnant to great intellects, from Moses and Mohammed to Pascal and Matthew Arnold, who protest always, but often in vain, at least from the plebeian point of view, against the worship of images."

Another phenomenon of emotional arrest is the banner, substituted for the fatherland, for whose sake are created honors and feuds. Thus, in politics, parties are designated by colors black, blue, red, according as men hold to one set of ideas or another. Thus also in parliaments there are the Right, the Left, and the Center; so, at the time of the rise of the new Italy, there was a fierce struggle over the emblems of the three colors, to display which every opportuuity was seized. So, again, the name of Verdi, at the same epoch, served as a symbol for the patriotic cry "*Viva Vittorio Emmanuele, Re d' Italia!*" The toga, like the flag, is a mystic symbol, and it symbolizes in the tribunals the majesty of justice. Nor does the bureaucracy disdain the use of symbols.

In his chapter on the pathology of the symbol, Ferrero narrates how it had been adopted by criminals, and is the hinge of such secret societies as the "Maffia" and the "Camorra." Our author relates how even madmen adopt symbols, as well as the sick, concluding: "Certainly we are here treating of disease, but the extraordinary intensity of the phenomenon proves how profound is the tendency of the human soul to reduce sensations, images, sentiments; to exchange the whole for a part; to concentrate all its energies upon some particular, which thus becomes more potent in its action. Certainly in those normal processes of reduction whence the symbol proceeds, this absorption of everything into itself of the particular, is not so intense as in these morbid cases, precisely because these are an exaggeration. But in any case the phenomenon of symbolism by reduction, and these phenomena of moral pathology, throw light upon each other."

The second part of Ferrero's essay is entitled Symbolism in Modern Law. This chapter contains precious and useful observations with regard to the manner in which the letter and the spirit of the code are applied. The greater part of the juridic ideas consecrated in our codes, and the manner in which they are applied—almost everything, in short, known as justice—is nothing but one gigantic mystic symbol, the effect of a fatal confusion of the sign with the thing, a spring of infinite evil to society, and above all of that greatest of evils: the possession, that is, of a justice which causes more torment, perhaps, than benefit. In

these utterances we recognize the great informing idea of the positive juridical school, the reasoning of Lombroso and of the other modern criminalists and sociologists. Ferrero, in summing up, to support his assertion, cites many practical examples, civil and penal, too long to be quoted here. He says: "From these rapid indications, which I hope to be able, in the future, to develop in a longer and more complete work, we may gather how the future of justice and of juridical institutions lies in the abolition of codes, in the abandonment of juridical principles which are dangerous generalizations and determining causes of ideo-emotional arrest; in the institution of boards of arbitration, composed of honest and intelligent persons, charged with judging *ex æquo et bono*, appealing, not to the authority of our fathers, but to the authority of their consciences: perhaps also it may be in the abolition of the profession of magistrate, and in a varied choice, often renewed, of arbiters, among persons of intelligence, instruction, and integrity, of diverse occupations; because the constitution of a class of magistrates favors professional ideo-emotional arrests. At all events, since the gravest danger to the right administration of justice lies in the production of this arrest, the normal and supreme scope of all reform should be to prevent, in the best manner possible, that for any reason ideo-emotional arrest should be produced in those who administer justice."

When that day dawns, if ever it see daylight, no pessimist will be able any longer to repeat, for the shame and condemnation of modern society, the bitter verses which Goethe has put into the mouth of Mephistopheles:

"Customs and laws in every place,
Like a disease, an heirloom dread,
Still trail their curse from race to race,
And furtively abroad they spread.
To nonsense, reason's self they turn;
Beneficence becomes a pest;
Woe unto thee, that thou'rt a grandson born!
As for the law born with us, unexpressed—
That law, alas! none careth to discern."

Guglielmo Ferrero—who, by the way, is quite a young man, not far advanced in the twenties—has shown in this book not only great promise but great achievement; and proved once more what a wonderful amount of talent is possessed by that Italian nation to which we owe so much of our culture and civilization.

SKETCH OF CHARLES A. LE SUEUR.

By DAVID STARR JORDAN,
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SOME years ago I began to collect material for biographical sketches of several of the early naturalists in America. Among these was CHARLES A. LE SUEUR, the artist, traveler, and naturalist, who was "the first to study the ichthyology of the Great American Lakes." Le Sueur traveled widely in Pennsylvania, New York, and New England from 1817 to 1828. He was an artist of high degree, a careful and faithful observer, and according to accounts, a man of most genial and attractive character. He had won a high reputation in Europe as an artist. As a naturalist he had been around the world with Péron and La Pérouse. He was one of the founders of the Academy of Natural Sciences at Philadelphia. When the famous socialistic colony was established by Robert Owen at New Harmony, Ind., Le Sueur was one of its members. He came down from Pittsburg in the famous "boat-load of knowledge" with which the colony was intellectually equipped.

During his stay at New Harmony, Le Sueur made considerable collections and many drawings, some of which are still preserved, and others have been published in the Journals of the Academy at Philadelphia. A most spirited portrait of the old Governor Vigo is still extant. I have received an account of the drop-curtain painted by Le Sueur for the old theater in New Harmony. On this curtain were represented a rattlesnake and the Falls of Niagara, as two natural features most characteristically American.

After the failure of the New Harmony colony, Le Sueur returned to Philadelphia, and probably went from there to Paris, where, according to Swainson, he earned a precarious livelihood as a teacher of painting. For the latter part of his life he was curator of the museum at Havre. His scientific work was done chiefly in America, and it ranked with the best of its kind at the time. Le Sueur's most important memoir was a monograph of the suckers, a group of American fishes constituting his genus *Catostomus*, each species being represented by a clever and accurate figure—drawing and engraving being both by the hand of Le Sueur. In 1878 I had occasion to speak of this paper as "an excellent one, comparing favorably with most that has since been written on the group." Other valuable papers were on certain blennies, rays, and flying fishes, accounts of new species from the West Indies, and descriptions of tortoises and other reptiles.

The Royal Society's Catalogue of Scientific Papers contains the titles of nine papers of which Le Sueur was joint author with

François Péron. These appeared in 1809 and 1810 in French scientific serials and deal with jelly-fishes and some other marine animals. Le Sueur was joint author with Anselme G. Desmarest of two papers on certain mollusks and sea-mosses in 1814 and 1815. The papers of which he was sole author number forty-three. They begin in 1813 with a memoir on several new species of mollusks and radiates, published in the Journal de Physique. The first six were written before he came to America, and he picked up material for the seventh on his way over. It deals with three new slug-like mollusks, and is entitled Characters of a New Genus (*Firoloida*) and Descriptions of Three New Species upon which it is Formed; Discovered in the Atlantic Ocean, in the Months of March and April, 1816, lat. 22° 9′. It appeared in Volume I of the Journal of the Academy of Natural Sciences of Philadelphia, in 1817. Dr. Ruschenberger relates, in his Notice of the Academy, that in the first year of the Journal, "Mr. Ord, anxious to forward the publication, translated or rather prepared the papers of M. Le Sueur from materials furnished by him, as that gentleman, who immigrated from France in 1816, possessed very little knowledge of the English language." The last three of the list appeared in Paris in 1827, 1831, and 1839 respectively. Two are on certain tortoises, the other is an observation on a bite of a viper. Three other papers, written while he was in this country, were published in Paris; the rest appeared in the Journal of the Philadelphia Academy, except one in the Transactions of the American Philosophical Society. He evidently restricted himself quite closely to the fishes and other aquatic animals, though with an occasional excursion among the reptiles.

His descriptions are clear, exact, and honest. His drawings are not accurate only, but spirited. They are works of art rather than mechanical representations. With less range of learning than Rafinesque and some other contemporaries, Le Sueur had, what Rafinesque had not, sound sense and faithfulness in the study of details. In America he was perhaps the first of that school of systematic zoölogy which regards no fact as so unimportant that it need not be correctly ascertained and stated—a method of work with which has been rightly associated the name of Prof. Spencer F. Baird. This attention to accuracy in detail marks the so-called "Bairdian epoch" in vertebrate zoölogy.

The pressure of other duties has led me to abandon the gathering of materials for the study of the lives of the earlier American naturalists. I therefore leave this sketch unfinished,* using it

* In the hope that this sketch may some time be completed, I ask any one having additional information regarding Le Sueur's history or his personality to send it either to the editor of The Popular Science Monthly or to the writer.

only as a reason for printing the most valuable of original documents concerning Le Sueur. This is a personal letter from the late Prof. Richard Owen, whose early life was spent at New Harmony, and who was my predecessor in the chair of Biology in the University of Indiana.

Prof. Owen writes as follows under date of December 14, 1886:

"Charles A. Le Sueur was, when I knew him in 1828, about fifty to fifty-five years of age, tall, rather spare in muscle, but hardy and enduring. He permitted his beard to grow, which at that time was quite unusual; hence he sometimes platted it and tucked it almost out of sight when he went from home. In New Harmony he usually went barenecked, often bareheaded, and in summer occasionally barefooted, or at least without socks. His hair had been dark, but was sprinkled (as well as his beard) with gray. His manner and movements were quick; his fondness for natural history (as it was then called) led him to hunt and fish a good deal.

"In summer he was fond of swimming in the Wabash, and I frequently accompanied him. He instructed me how to feel with my feet for *Unios* and other shells as we waded sometimes up to our necks in the river or ponds, searching to add to our collections. When he went fishing with others he always exchanged his fine common fishes for the smallest and to them most indifferent-looking, when he recognized some new species or even variety. This item I have from Mr. Sampson, who is well acquainted with the fish of the Wabash, but who confesses he could see no difference in many caught until Mr. Le Sueur, who at once detected that difference, had pointed it out.

"He was temperate and active in all his habits, smoking being the only objectionable habit in which he indulged. His temper was quick and used to call out an occasional "God bless my soul!" the only approach to anything like irritation that he evinced; he was very kind-hearted.

"In conversation with Agassiz about Mr. Le Sueur, the great Swiss ichthyologist paid a high compliment to Le Sueur's acquirements in that department, considering him then (as I inferred) the next best to himself at that time in the United States. He was, however, I judge, remarkably conversant with other branches of biology, inasmuch as nearly all the magnificent drawings he had made when left in New Holland (as it was then called) were mammals, chiefly the ornithorhynchus, echidna, and other rare animals. In showing his drawings he generally offered a lens, that you might see every hair distinctly delineated.

"He was a magnificent artist, good alike in drawing and coloring. I have some of his sketches yet, in which, when I was taking drawing lessons from him, he showed me how to outline, for in-

stance, the skeleton of the human figure, then to add the muscular system, then the clothing, drapery, etc. We usually took views from Nature. Although so minute in details of fine paintings, he was equally good in large scenery. For many years we had here the scenes he painted for a Thespian Society of this place, where, amid the forest trees, he had squirrels, birds, etc. Being fond of hunting, he had made to order by a native gunsmith, who was quite a genius, a double-barrel piece, one a rifle, the other a smooth-bore. Gillson, the gunsmith, made the barrels, bored the rifle, made the stock, and an admirable lock; the stock was inlaid with silver and engraved by the same skillful hand, bearing Le Sueur's name and an appropriate device. I do not remember exactly the price, but think it was about a hundred dollars.

"In consequence of his having been with La Pérouse (until, fortunately for his life, he was left to work up the animals of Australia), the French Government gave him a pension, which he drew annually, until they notified him that, unless he returned and gave his time and talents to his native country (France), the pension would be withheld. He went at a time when I was absent, and those who here knew him well have forgotten the date. He became curator of the museum at Havre, and then, after some years, died and was buried there. The exact date of his death those three have also forgotten.

"When he came to New Harmony during the social experiment he was directly from the West Indies, and brought a young lad and a child, both of whom subsequently married, but both are now dead. It was from their relatives that I expected to get dates, but failed.

"When the 'Preliminary Society' (at New Harmony) resolved itself into the (1) Educational, (2) Agricultural, and (3) Commercial Societies, Mr. Le Sueur joined the first, and I have in my box of valuable papers a deed of a lot (for the purpose of erecting a foundry), executed by the Educational Society, and signed by my father-in-law, Mr. Neef, and his family, Drs. Troost, C. A. Le Sueur, William Phiquepal, and a number of others.

"Some of the relatives of those who came with him think there was a notice in some public journal of his death, etc., but I never saw it. I just recall two incidents:

"When we were together, going sketching, I think, we found and killed a large blacksnake, uncommonly distended. Mr. Le Sueur, when we reached home, used a large syringe and injected water into the stomach, from which he then stripped four young rabbits. Another time we obtained a female opossum, and he very deftly dissected it and showed me the young adhering to the small teats in the pouch or marsupium."

EDITOR'S TABLE.

SCIENCE IN EDUCATION.

MUCH as has been written on this subject there seems still to be room for further insistence on the truth that the one living element in every system or scheme of education is science. By this we do not mean—indeed, are very far from meaning—that what is called physical science is the one useful subject of instruction; we mean that except in so far as education is animated by the spirit of science it is dead, and, for all purposes of mental development, useless. An excellent address on Scientific Method in Board Schools was lately delivered in London, England, by Prof. H. E. Armstrong, F. R. S. We shall take an early opportunity of transferring it to our columns, trusting that it may be widely read, as it presents the gist of the matter in comparatively few words. Prof. Armstrong bears testimony to the extreme slowness with which the educational world in England has moved in regard to giving science teaching the place to which it is entitled in school curriculums; but, on the other hand, he is able to speak encouragingly as to the results that have flowed from the intelligent and zealous efforts of a single teacher of scientific method, and he is evidently of the opinion that a better day is dawning for science teaching generally in the secondary schools of the United Kingdom. He refers in terms of high praise to Herbert Spencer's classic work on education. His words are worth repeating here: "It is a book which every parent of intelligence desiring to educate his children properly should read; certainly every teacher should have studied it thoroughly, and no one should be allowed to become a member of a school board who, on examination, was found not to have mastered its contents."

The point, however, which we wish to make to-day is not that a certain amount of natural science should form an element in all education, for that is becoming more widely recognized and more fully accepted from year to year; but that all instruction should be pervaded by the scientific spirit, and that the teaching of what is called "science" is of value not only for the knowledge conveyed, but still more as furnishing, in proper hands, a type of what all teaching should be. If science itself is not taught scientifically, it is like salt that has lost its savor, utterly worthless; it becomes in such a case a mere burden on the educational system instead of its prime motor. In the address to which we have above referred, Prof. Armstrong deplores the bookish and unfruitful methods still widely in use in England, and unless we are mistaken the evil is quite as rife in this country. The fact is that even among teachers of science the true scientific spirit is by no means common. To have learned a certain range of scientific facts, and gained some comprehension of the methods by which those facts have been ascertained and by which further advances in scientific discovery must be made is not sufficient; it is necessary that the teacher's mind should be liberalized and quickened by the conception that in every branch of knowledge, in every pursuit, in every industry, in every line of thought and effort, the fundamental distinction of scientific and unscientific holds just as firmly as in the case of the best-explored departments of natural science. Are merely conventional views to be discarded in chemistry and physics? Certainly, the teacher of science will reply. How, then, about history, literature, and politics? It would seem as if a "certainly" would be in place

here, too, and doubtless if the question were pressed it would come; but how few among the scientifically trained take home to themselves heartily and thoroughly the truth that if scientific method is good for anything it is good for everything! But no one can be a true and inspiring teacher of science who does not feel in his inmost consciousness this universal applicability of scientific method, and who, in so far as he has been initiated into that method, does not rejoice in a sense of glorious liberty and power. It must be acknowledged that not a few men of "mere letters," as they are sometimes called, have gained a fuller entrance into the intellectual freedom which science bestows than many who have made science their special study. Such men as teachers will be eminently successful; they will have an intuitive sense of the distinction between essentials and non-essentials; they will grasp the roots of their several subjects; their teaching will have a certain organic quality that will cause it to germinate in the minds of others.

If we were asked what is the most characteristically or typically scientific idea that the mind can entertain, we should answer, with little hesitation, *The idea of utility*. Why? Because it involves the two fundamental ideas of the connection between cause and effect, and of the adaptation of means to ends; and because it points to an object apart from which science becomes mere intellectual trifling. It is possible to take an unduly narrow view of utility, but it is in no way necessary. There is nothing in the word itself to call for a narrow interpretation. On the contrary, it suggests the widest possible range of advantage for the human race. The conception of utility is one which we must more and more apply to our systems of education. In regard to any and every branch of study, let us boldly ask, as it is our duty to do, What are its uses? What is it going to do for those who are exercised thereby? Has it a bearing on health of body or of mind, or are its uses exclusively social? In the latter case, do they refer to permanent or to transitory social conditions? If to transitory conditions, how far is it desirable that these should be allowed to mold the education of the rising generation? No harm can come of pressing these questions one and all; and till we have answers to them—careful and satisfactory answers—we shall have no true criticism of modern education. If there is anything in this wide world that should be able to give a most rigorous account of itself it is the education we give our children. We started by saying it should be scientific, and now with equal conviction we declare that the first step toward being scientific is that it should be useful. A useful education—one founded upon and justified by use—is itself a constant training in scientific method and the best possible introduction to the scientific spirit. On the contrary, an education that can not constantly plead the justification of utility makes so far for unscientific habits of thought; for what can possibly be more unscientific than effort without definite and justifiable purpose?

Some persons entertain a vague idea that a dominantly scientific education must be dogmatic in tone, and therefore an unsuitable preparation for practical life, in which so many problems present themselves that require tact and a careful balancing of probabilities rather than the strict methods of the laboratory. Herein we see the fatal mistake of narrowing our idea of science too much. The logic of chemistry is one thing, the logic of politics is another; but each has its logic, each admits of scientific treatment. As we pass from one to the other we simply have to widen our methods of inquiry, and allow for somewhat less of absoluteness in our conclusions; but we need not lower the scientific ideal, and as to the scientific spirit, it can be seen to almost greater advan-

tage in a sphere in which the difficulties of analysis and the chances of error are relatively greater. So long as we only think of science in connection with the so-called natural sciences, the true conception of science will not reveal itself to us, and education in general will remain unfructified by the scientific spirit. But when we reach the point of accepting the methods of physical science as far as they go, and applying them, with such modifications as the case may call for, to all other branches of knowledge, holding ever as our clew the idea of utility broadly and liberally understood, we shall be fairly on the way to that revolution, or rather transformation, of our educational systems which the new age demands.

THE ROYAL SOCIETY AND THE DARWINIAN THEORY.

It will be remembered that Lord Salisbury, in the address delivered by him last autumn as President of the British Association, laid stress on the difficulties which he found in the way of accepting the doctrine of evolution, and quoted in support of his position some observations made several years ago by Lord Kelvin. Lord Kelvin himself has now been delivering an annual address as President of the Royal Society, and part of his duty in connection therewith was to announce that the society had this year conferred the "Darwin Medal" on Prof. Huxley as a "token of the value put by the society on the part of his [Prof. Huxley's] scientific activity bearing more directly on the biological ideas with which the name of Charles Darwin will always be associated." That the Royal Society should have instituted a Darwin medal speaks plainly enough as to the hold which Darwin's theory of the origin of species has obtained upon the scientific world; and that the medal should have been awarded to so earnest and thoroughgoing a champion of that theory as Prof. Huxley is a plain indication that scientific opinion is not taking any backward steps in this matter. In referring to the award Lord Kelvin chose his words with evident care; but no fault could be found, so far as either Darwin or Huxley was concerned, with the following neatly turned sentences: "That advocacy [Prof. Huxley's] had one striking mark: while it made, or strove to make, clear how deep the new view went down, and how far it reached, it never shrank from striving to make equally clear the limits beyond which it could not go. In these latter days there is fear lest the view, once new but now familiar, may, through being stretched further than it will bear, seem to lose some of its real worth. We may well be glad that the advocate of The Origin of Species by Natural Selection, who once bore down its foes, is still among us, ready, if need be, to save it from its friends."

At a dinner which followed the meeting at which these words were uttered, Prof. Huxley having been called upon to respond to the toast of "The Medallists," took occasion to say that the theory propounded by Darwin "has never yet been shown to be inconsistent with any positive observations. . . . I am sincerely of the opinion," he added, "that the views which were propounded by Mr. Darwin thirty-four years ago will be understood hereafter to mark an epoch in the intellectual history of the human race. They will modify the whole system of our thoughts and opinions, and shape our most intimate convictions." In the face of such a declaration, delivered under the circumstances described, it would certainly be well if the honest and worthy people who are always flattering themselves on the strength, generally, of this or that pulpit utterance, that natural selection and the doctrine of evolution are exploded theories, would make up their minds that practical men of science are the best judges as to what theories are helpful, and so far deserv-

ing of acceptance, and that the criticisms of theologians and other amateurs, however well meant, are apt to be beside the mark.

AGNOSTICISM.

PROF. MAX MÜLLER contributes to the Nineteenth Century for last December an article the title of which is, Why I am not an Agnostic. Just what the true definition of agnosticism may be we should not care to venture an opinion; but what interests us chiefly in Prof. Müller's article is the extreme similarity between the position he takes up and that of Mr. Herbert Spencer as set forth in First Principles. "If," he says, "we have to recognize in every single object of our phenomenal knowledge a something or a power which manifests itself in it, and which we know, and can only know, through its phenomenal manifestations, we have also to acknowledge a power which manifests itself in the whole universe. . . . *That* it is, we know; what it is by itself, that is out of relation to us, of course we can not know; but we do know that without it the manifest or phenomenal universe would be impossible." This is the Spencerian philosophy exactly, and is also the philosophy, we do not doubt, of a large portion of the thinking world of to-day. Mr. Spencer has never professed himself an agnostic. Apart from the objections urged by Prof. Müller, he would probably consider the term one of far too uncertain meaning to serve for a definition of any views which he may hold, whether of a positive or of a negative character.

LITERARY NOTICES.

WOMAN'S SHARE IN PRIMITIVE CULTURE. By OTIS TUFTON MASON. New York: D. Appleton & Co. Pp. 295. Price, $1.75.

THIS is the first volume of an anthropological series under the editorial direction of Prof. Frederick Starr, of the University of Chicago; the works of which, intended to be of popular interest, will be in every case written by authorities who will keep scientific accuracy in the foreground. The present essay sets forth woman's share in the culture of the world by her works, and shows that her achievements have been in the past worthy of honor and imitation and have laid the foundation for arts of which all are now justly proud. The idea is rejected in the very beginning that women are treated with systematic cruelty or are degraded, in any nation, however savage; for "it is not reasonable to suppose that any species or variety of animals would survive in which the helpless maternal half is subjected to outrageous cruelty as a rule," and the taste and skill women show in the arts that fall to their province are against such a supposition. On the other hand, a division of duties generally prevails, which, though it may not accord with the artificial, conventional system of European society, is usually adapted to the circumstances of the tribe, and is not inequitable. In the list of spheres of work, woman is introduced first as the food-bringer, finding supplies in the stores of Nature, taking care of them and preparing them for consumption. In this field she set agoing a multiplicity of industries in prehistoric times, and became of necessity an inventor of experiments, tools, and processes. Next she appears as a weaver, making baskets and the native cloth and mats, and spinning, netting, braiding, sewing, and embroidering, and for each of these tasks having again to find material and to invent and fashion suitable tools. Having to deal with the game killed by the man and to apply all the material to the best use, she becomes a skin-dresser. A bewildering list is given of the animals whose skins native American women knew how to dress; and, "if aught in the heavens above or on the earth beneath, or in the waters, wore a skin, savage women were found on examination to have had a name for it, and to have succeeded in turning it into its primitive use for human clothing, and to have invented new uses undreamed of by its original owner." Here, again, were new tools to be invented. "Women were the first ceramic artisans, and developed all the technique, the forms, and the uses of pottery." In this work and in her textile fabrics woman has had opportunity to de-

velop her faculties as an artist; and examples are given of the patterns that savage women in America have worked out, which for beauty and harmony of design are not more than equaled by the most exquisite specimens of Grecian work in the same lines. American Indian costumes are shown which may be compared with the most picturesque. While there were burden-bearers among the animals before, "the idea of modifying a natural object for the purpose of creating a carrying tool seems first to have occurred to the human female." It is not enough, in speaking of savage women, says the author, "to say that they, as a class, do this or that. It should be also asked how many of these are performed by one woman—in short, by every woman." This thought is introductory to a consideration of the diversity of occupations in which they must be proficient —to a chapter on "The Jack-at-all trades." Woman is further presented as "The Founder of Society," by virtue of her motherhood and what it implies, and as "The Patron of Religion." Finally, "in whatever actions the primitive women excelled—and the number is not small—they surely deserve the apotheosis they have received for their development of the maternal side of life. . . . For the highest ideals in civilization, in humanitarianism, in education, and government, the way was prepared in savagery by mothers and by the female clan groups, and the most commanding positions are at this moment in their possession." The book is good reading, and is abundantly and handsomely illustrated.

HOOFS, CLAWS, AND ANTLERS OF THE ROCKY MOUNTAINS BY THE CAMERA. With an Introduction by the Hon. THEODORE ROOSEVELT. Denver, Col.: Frank S. Travis. Pp. 7, with 32 Plates.

THIS is a book of photographic reproductions from life of wild game—deer, antelope, Rocky Mountain goat, bighorn, puma, bison, bear, etc.—of the Rocky Mountains. Most of the pictures were taken by Mr. and Mrs. A. G. Wallihan, settlers in northwestern Colorado, accomplished sportsmen both, naturalists, and photographers. They were necessarily taken under great disadvantages; for a suitable position had to be secured of animals which would vanish at the least alarm, with favorable light-exposures. It is not wonderful, therefore, that the failures vastly outnumbered the successes. Only successes are given. In order to make the collection of wild animals found in the Rocky Mountains complete, a few photographs taken by others than Mr. and Mrs. Wallihan are used. The text gives sketches of the lives of Mr. and Mrs. Wallihan, by themselves, stories of their adventures among the animals, and incidents of the circumstances under which the several photographs were taken. There is no posing for positions in these pictures; the animals are represented truly as they were found, unwitting that anything was going on, or at the instant when they were startled by the first perception of the novel proceeding. Among them are a buck which has just noticed the photographic apparatus, with his doe still unconscious; a group of deer at the ford on a winter morning; two startled bucks just ready to jump; a doe swimming Bear River; a buck standing alone in his glen; a pair crossing a stream; three alarmed antelopes; herds and groups of antelopes in different attitudes; Rocky Mountain goats on their cliff; elks single and in groups; a puma on the lookout from a tree top, and a puma treed; bighorns startled, a wild cat, and buffalo; bears in the berry patch; beavers at work; sage hens, a wolf in search of breakfast, a jack-rabbit, a prairie-dog colony, listening deer, a rattlesnake coiled to strike, and game pictures. Mr. Roosevelt, who is acquainted with the game, speaks admiringly of the naturalness and accuracy of the attitudes, and believes that the book is "unique and of the utmost value." We think naturalists and artists will agree with him.

TERTIARY RHYNCHOPHOROUS COLEOPTERA OF THE UNITED STATES. By SAMUEL HUBBARD SCUDDER. Washington: Government Printing Office. Pp. 206, with Twelve Plates.

THIS work is published as Monograph XXI, of the United States Geological Survey. The author published in 1890 an account of all the Tertiary insects of the country known up to a few years, as far as regarded the lower orders; but the higher orders were nearly untouched. These furnished an immense amount of material, the elaboration of which was begun at once. The

present work is a first installment toward a history of our fossil Coleoptera, or beetles, of which one hundred and ninety-three species are treated. Although it can not be supposed that more than a mere fragment of the vast host of insects entombed in the Tertiary rocks has been identified, such a variety and abundance of forms have been discovered as to make it clear that there has been but little important change in the insect fauna of the world since the beginning of the epoch to which they belong. In the earlier Tertiaries we have in profusion representatives of every one of the orders of insects; and every dominant type which exists to-day has been recognized. Even many of the families which have now but a meager representation have been discovered; and though many extinct genera have been recognized, no higher groups, with a single exception or two, have been founded on extinct forms. The parasitic groups are represented, and many of those which in the present time show peculiar modes of life.

BULLETINS OF THE UNITED STATES GEOLOGICAL SURVEY. Nos. 97 to 117. Washington: Government Printing Office.

No. 97 is a description of the Mesozoic Echinodermata of the United States, by W. B. Clark; No. 98, an Account of the Flora of the Outlying Carboniferous Basins of Southwestern Missouri, by David White; No. 99, a Record of North American Geology for 1891, by N. H. Darton; No. 100, a Bibliography and Index of the Publications of the Geological Survey, with the laws governing their printing and distribution, by P. C. Darton; No. 101, Insect Fauna of the Rhode Island Coal Field, by S. H. Scudder; No. 103, a Catalogue and Bibliography of North American Mesozoic Invertebrata, by C. B. Boyle; No. 103, High Temperature Work in Igneous Fusion and Ebullition, chiefly in relation to pressure, by Carl Barus; No. 104, The Glaciation of the Yellowstone Valley north of the Park, by W. H. Weed; No. 105, The Laramie and the overlying Livingston Formation in Montana, with map, by W. H. Weed (with report on Flora, by F. H. Knowlton); No. 106, The Colorado Formation and its Invertebrate Fauna, by T. W. Stanton; No. 107, The Trap Dykes of the Lake Champlain Region, by J. F. Kemp and V. H. Masters; No. 108, A Geological Reconnoissance in Central Washington, by J. C. Russell; No. 109, The Eruptive and Sedimentary Rocks at Pigeon Point, Minn., and their Contact Phenomena, by W. S. Bayley; No. 110, The Palæozoic Section in the Vicinity of Three Forks, Montana, by G. P. Merrill; No. 111, Geology of the Big Stone Gap Coal Field of Virginia and Kentucky, by M. R. Campbell; No. 112, Earthquakes in California in 1892, by C. D. Perrine; No. 113, Report of Work done in the Division of Chemistry during the Fiscal Years 1891–'92 and 1892–'93, by F. W. Clarke; No. 114, Earthquakes in California in 1893, by C. D. Perrine; No. 115, a Geographic Dictionary of Rhode Island, by Henry Gannett; No. 116, a Geographic Dictionary of Massachusetts, by Henry Gannett; No. 117, a Geographic Dictionary of Connecticut, by Henry Gannett.

A HISTORY OF THE UNITED STATES FOR SCHOOLS. By JOHN FISKE, Litt. D., LL. D. With Topical Analysis, Suggestive Questions, and Directions for Teachers, by FRANK ALPINE HILL, Litt. D. Boston: Houghton, Mifflin & Co. Pp. xxi + 474. Price, $1 net.

IT has been said that children's text-books should be written by the best authors, and the wisdom of the remark is evident from an examination of this treatise from the pen of the thoroughly equipped and facile author and lecturer, John Fiske. Prof. Fiske tells the story of America, from the voyages of the Norsemen down to the events of 1893, with such vividness that the pupil is not likely to neglect his history lesson (unless to read ahead), and with such regard for logical connection that he can not fail to gain from it a comprehensive view of the march of events. Indeed, the chief interest of this book from the scientific standpoint is that historical events are arranged in it so as to link them in natural sequence and to aid in teaching the great lesson that every effect has its cause and every cause must produce an effect. The illustrations are a striking and valuable feature of the book. Portraits are especially numerous; they include the bewigged and beruffled worthies of exploration and colonization times, British and American generals of the Revolution, our Presidents and other statesmen from Wash-

ington down, Union and Confederate commanders of the civil war, and the chief American authors and inventors. There are also views of ancient buildings, reproductions of ancient maps, and a variety of other illustrations showing objects of historic interest. The growth of the territory of the United States is shown in a number of small maps. Among the materials for reference appended to the volume are the Constitution of the United States, classified tables of the States, lists of books on the history of the several States and on successive epochs, a pronouncing vocabulary, and a note on the calendar. The first chapter of the book is an account of Indian life in America at the time of the discovery.

BIOLOGICAL LECTURES AND ADDRESSES. By the late ARTHUR MILNES MARSHALL, D. Sc., F. R. S. New York: Macmillan & Co. Pp. 363. Price, $2.

THERE are some scientific books that are dry and technical but have attractive titles, and others with technical titles that are eminently readable: this belongs in the latter class. The thirteen lectures and addresses of which it is made up comprise several delivered by Prof. Marshall as President of the Manchester Microscopical Society, others delivered before students' societies in Owens College and other organizations. Among the topics treated are the influence of environment on the structure and habits of animals, the theory of change of function, butterflies, inheritance, the shapes and sizes of animals, animal pedigrees, and death. Taken together they afford a general view of the recent progress of science in the field of biology. In all the addresses the language used can be comprehended readily, and the ideas presented can be grasped easily by every ordinarily well-read person.

GENERAL LEE. By FITZHUGH LEE. Great Commanders Series, edited by General JAMES GRANT WILSON. New York: D. Appleton & Co. Pp. 433. Price, $1.50.

MUCH aid in comprehending the course of events in the civil war, and especially in appreciating the reasons for the various movements on the Confederate side, is afforded by this extended history of Robert E. Lee's military career. But two chapters are given to the first fifty-four years of his life, more than half of which was passed in engineering and cavalry service in the army of the United States. Lee resigned his commission as lieutenant colonel April 20, 1861, and was immediately appointed major general and commander in chief of the State troops of Virginia. His relative and biographer expresses the regret of all students of American history that General Lee never wrote anything concerning his career and campaigns, for an account from his point of view would have settled very many conflicting opinions. He intended to write, not his personal memoirs, but a record of the deeds of his soldiers. He waited for a "convenient season," but as he lived only five years after the close of the war such a time never came. In this volume some of his testimony upon the great events in which he took such a prominent part is furnished by inserting extracts from his private letters, now first published. These letters, also, with others of the period before the war, show what manner of man he was, and nowhere now will it be denied that his character was one to be admired.

Lee was in Richmond hard at work organizing the Confederate forces when the first battle of Bull Run was fought. His own first campaign took place in what is now West Virginia, and was not successful. He was then sent south to apply his engineering skill in improving the defenses of Charleston and Savannah. It was on March 13, 1862, that President Davis appointed him commander of all the forces of the Confederacy. The battles on the Chickahominy in the latter part of June were fought under his orders. From that time to the end of the war most of the hard fighting took place between the northern and the southern capitals, where Lee was actively engaged. Here occurred the battles of Manassas, Sharpsburg, Fredericksburg, and Chancellorsville, and then Lee made his masterly advance that was checked at Gettysburg. After this he operated mainly on the defensive until the great surrender at Appomattox. Lee's phrase in his farewell to his soldiers—"The Army of Northern Virginia has been compelled to yield to overwhelming numbers and resources"—was no farfetched excuse for defeat. While this volume does not aim to provide data for

a comparison of Lee's tactics with those of the successive commanders opposed to him, it does show that lack of food, clothing, and munitions of war had a large share in conquering his army. It was an expedition to acquire shoes that precipitated the contest at Gettysburg, and the verdict of a young Irishman, who served on Fitz Lee's staff, concerning the Confederates was, "I never saw men fight better, but they don't ate enough!"

After the war many honorable and lucrative positions were offered to General Lee, but he chose to accept the presidency of Washington College, on a salary of fifteen hundred dollars. In this position he died, and the name of the college was changed to Washington and Lee University in his honor.

A steel portrait by Hall is the frontispiece of this volume; there are also several maps and a notably good index.

POPULAR ASTRONOMY. A General Description of the Heavens. By CAMILLE FLAMMARION. Translated from the French by J. ELLARD GORE. New York: D. Appleton & Co. Pp. 685. Price, $4.50.

THIS work, the author says, is written for those who wish to have an account of the things which surround them, and who would like to acquire, without hard work, an elementary and exact idea of the present condition of the universe. M. Flammarion is one of that race of brilliant writers on scientific subjects which France has developed within the past few years, who, endowed with great powers of the imagination and possessed of admirable gifts of style, have the faculty of presenting the truths of their special branches in the most vivid and picturesque language. He is not addicted to the faults, with which some of his school are chargeable, of indulging in exaggeration, and of seeking effect at the expense of exactness. While he falls below none of them in vigor of description and power of interest, he is true to science, and not inaccurate. The present work has had a circulation at home probably unequaled among scientific books, and has received a distinguished reward of merit from the French Academy of Sciences; besides which the author has been given various other honors. The present edition of the Popular Astronomy has been translated, with the author's sanction, by J. Ellard Gore, author of other popular astronomical works, who has also edited it so as to incorporate the results of the discoveries that have been made since the French edition went to press, and has reduced the figures given by the author to English measures. M. Flammarion begins his picture with a presentation of the earth as a body in the sky, and as that one whose position and motions controlled the ideas of the ancients respecting the universe, which, in the ignorance then existing of the relation of the earth to the other bodies, were infected with many errors; and he describes the slow process by which these errors were corrected. The question, How was the earth formed? suggests an outline of the nebular hypothesis, which is given. From this planet the reader is taken to the moon, the nearest body to it, of which are given its astronomical elements and a physical description; then to the planets, in the order of their distances from the sun, with consideration of their apparent and real motions. In connection with the account of Uranus—besides our being told the mortifying fact that the existence of the earth and all its great men and great enterprises is and must always remain unknown to the people thereof—a discussion of the question of life in other worlds is given, with the conclusion that though the conditions in them are not compatible with the life of such beings as we know, we have no right to deny that there may be other beings adapted to those conditions. The discussion is continued in the chapter on Neptune, where the author declares that such a thing as a sterile and uninhabited desert world is contrary to the acts and views of Nature as we know her. The nature and orbits of comets are discussed. Are they really composed of carbon—diamonds of the sky? "Their importance would be much greater still if they should be found to carry in them the first combinations of carbon, for it is probable that it was by these combinations that vegetable and animal life commenced on the earth and the other planets, and thus these vagrant bodies might be the sources of life on all the worlds." From another point of view the author gives reasons for supposing that comets' tails—considering the immense velocities at which they are carried, forty thousand miles a second in the

perihelion of the comet of 1843—may be not substantial, but merely representative of a state of ether set in a particular undulating motion by the influence of the comet. The origin of comets may be various—from solar or planetary explosions; from explosions in distant stars, or from the scattered matter in space—any or all of these. Meteoric stones, meteoric showers, and cosmic dust are considered, and an equal variety of possible origins is supposed for them. The sidereal system comes next under review, in the several categories of the constellations, the positions of the stars in the sky, their magnitude or brightness, the measurement of celestial distances, the light of the stars, changes observed in the heavens, double, multiple, and colored stars, the proper motions of the stars, and the structure of the visible universe. A hopeless effort is made to convey a conception of the magnitude of the universe. We might sail forever through it with the velocity of light, and still be only at the beginning of our journey. The last chapter gives a simple lesson in home astronomy—a fitting introduction to Mr. Serviss's Astronomy with an Opera-Glass.

THE LIFE AND INVENTIONS OF THOMAS ALVA EDISON. By W. K. L. DICKSON and ANTONIA DICKSON. New York: Thomas G. Crowell & Co. Pp. 362. Price, $4.50.

THIS biography, the authors claim, has been prepared "under unique facilities for procuring fullness and accuracy of fact, and thence for creating a living and sympathetic picture of the man. The materials have been obtained from the observations of a close business and friendly association of the authors with their subject for a period of thirteen years, and from the verbal and written data which Mr. Edison has most freely and kindly supplied. To this should be added manuscripts from the leading members of the Edison staff and the inventor's private files of periodicals, covering over thirty years, and embracing the best work of American and transatlantic journalism." Having made careful and discriminating use of this material, the authors believe they have given the first full, accurate, and, to Edison, satisfactory life of the inventor. Besides the matter conventionally appropriate to a biography and the accounts of Edison's numerous and valuable inventions, the book abounds in anecdotes, lively sketches, dramatic passages, and little incidents illustrating the vicissitudes of the subject's career, his peculiar turns of mind, his skill in adaptation and manipulation of already existing mechanism to give effect to his new ideas, and the ever-consistent bent of his genius. The account of his work with the electric light is varied with the descriptions of the journeys of his agents in South America and Asia in search of the best fiber for lamps, occupying two chapters. There are given us here the stories and descriptions of Edison's many experiments and improvements in telegraphy, his vote-recorder, his phonograph and allied instruments, his work in electric railroading, the kinetoscope, and the other applications. The laboratories at Menlo Park and Orange, and the various shops, are noticed in such a way as to give a current view of the development of the electric industry from its modest and doubtful beginnings to its present triumphant prosperity. The tone of the biography is one of enthusiastic admiration, and the book is profusely illustrated.

DEFECTIVE SPEECH AND DEAFNESS. By LILLIE EGINTON WARREN. New York: Edgar S. Werner, 108 East 16th St. Pp. 116.

THIS book is written primarily with reference to children, especially in schools, who have a deficient sense of hearing, but whose teachers and even their parents may not be aware of the fact. "Yet the deafness may be serious enough to interfere with progress in their studies. Such children are frequently considered dull and inattentive pupils. Many suffer from catarrhal affections and thereby present a variability of hearing, which makes them appear to better advantage on some days than on others. Thus they add to the teacher's difficulty in distinguishing them from the willfully disobedient. If one ear is defective and the other not, there will be times when the child hears well, and soon after, having turned his head, he fails to understand and becomes indifferent." The number of children troubled with defects in hearing has been found much larger in the schools of several different countries than any one at first thought would

be likely to suppose; and the census returns give surprising accounts of the number of totally deaf persons, it being about 300,000 in the United States. There are further those who are somewhat deaf in one ear, those who are obliged to take a forward seat in the church and the public hall, and those who are conscious of a gradual failing of the hearing sense; also children and adults who receive sounds slowly because they lack quick perception, and persons who fail to distinguish particular shades of sound. With these affections the author couples defects of speech, such as stammering, stuttering, lisping, mumbling, and mouthing, as mostly originating in some organic fault. The object of her little book is to show that fluent speech may be obtained and understood by all who suffer from the different phases of deafness and the different degrees of imperfect utterance. In it she considers the cases of the Deaf Mute and the Stammerer; the Very Young Deaf Child; Signs, Finger-spelling, and Speech; Teaching the Dumb to Speak; the Child suddenly Deaf and the Child growing Deaf slowly; the improvement and development of hearing; How the Hard-of-hearing Adult may enjoy Conversation; Dull Pupils; Invented or "Pathological" Language, Lisping, Careless Speech, Stuttering, Stammering, and Cleft Palates. The author has a full understanding of her subject, presents it in a clear and earnest way, and urges the need for its more careful consideration by parents, and educators generally.

BULLETIN OF THE UNITED STATES FISH COMMISSION, Vol. XII, for 1892. MARSHALL McDONALD, Commissioner. Washington: Government Printing Office. Pp. 478, with One Hundred and Eighteen Plates.

THE bulletins are issued under a joint resolution of Congress authorizing the publication, from time to time, for distribution in parts and collection in annual volumes not exceeding five hundred pages each, of any matter furnished by the Fish Commission, relative to new observations, discoveries, and applications connected with fish culture and the fisheries. The present volume contains a bibliography of the salmon of Alaska and adjacent regions, and a life history of the salmon, by Tarleton H. Bean; a paper on the viviparous fishes of the Pacific Coast of North America, by C. H. Eigenman; an account of the fishes of Texas and the Rio Grande Basin, considered chiefly with reference to their geographical distribution, by B. W. Evermann and W. C. Kendall; a report on the salmon fisheries of Alaska, by Marshall McDonald; a summary of the fishery investigations of the Albatross, 1882–'92, by Richard Rathbun; a report on the fyke net fisheries of the United States, and Notes on Fishes of the Northern Coast of New Jersey, by H. M. Smith; an account of the oyster industry of Maryland, by C. H. Stevenson; and two or three papers of more special interest.

AËRIAL NAVIGATION. By J. G. W. FIJNJE VAN SALVERDA. Translated from the Dutch by GEORGE E. WARING, Jr. New York: D. Appleton & Co. Pp. 209. Price, $1.25

THERE seems to be good reason for believing that the next great triumph of science will be in the field of aërial navigation. The number and ability of the investigators who are now at work upon this subject, the encouraging results and the widespread interest that their efforts have secured, furnish substantial ground for this belief. After a historical introduction and a discussion of the military importance of aërial navigation, Mr. Fijnje considers the obstacles in the way of navigating balloons, stating the practical results already reached. He then passes to the flight of birds, from the several varieties of which—rowing, hovering, and sailing—the principles of flying machines proper are derived. Three kinds of machines of the "heavier than air" class are described in a brief chapter. Although MM. Renard and Krebs in 1885 succeeded in driving an elongated balloon at the rate of fourteen miles an hour, the author is convinced that balloons must give place to flying machines. Among his conclusions concerning the latter are that a flying machine must be supported by a large and strong aëroplane, which must not be utilized to give forward motion. There must be an independent motor, working continuously, and operating through propelling screws or other device. Some later matter published by the author separately from the foregoing gives

the results of investigations by Prof. S. P. Langley, of the Smithsonian Institution, and by Hiram S. Maxim, the English inventor. Colonel Waring has supplemented his translation of Fijnje's book with abstracts of two still later announcements of results by Prof. Langley, and some extracts and illustrations from a study of a practical air ship contributed by Mr. John P. Holland to Cassier's Magazine. The reader may obtain from this volume an understanding of the problems that have to be solved before the air can be navigated, and a knowledge of lines along which these problems are being approached.

A Bird-lover in the West. By Olive Thorne Miller. Boston and New York: Houghton, Mifflin & Co. Pp. 278. Price, $1.25.

Of old the poet Horace warned us that "black Care sits behind the horseman and does not withdraw from the ship," but Mrs. Miller assures us that the way to truly recreate is to leave our hurries and worries behind us and seek some unfamiliar spot where we may commune with Nature. Even with her explicit directions this may not be easily accomplished. Her example is, however, of more practical value than her advice.

It is not the going away, nor change of scene, nor yet strength of will, that dismisses the dark follower, but the substitution of a greater interest for our own petty concerns. If we can not journey to Cheyenne Mountain, there are new worlds to be discovered about us, and this book shows such loving study of bird life that some may be tempted to begin it at home.

Wherever the author finds herself—at the foot of the Rocky Mountains, beside Great Salt Lake, or in "the middle country"—her first inquiries are for her winged neighbors. In the forest and in the cañon she spends days observing the manners and habits of the wren, chat, or blue jay. Incidentally she notes that poets take too much license with the traits of her feathered friends. "The voiceless swallow," "forgetful thrush," and "mourning dove" are base misnomers. The coo of the dove "has a rich, far-off sound, . . . expressing a happiness beyond words," and not one of the swallow tribe can be called mute.

In the arid country the author comes upon a housewife who cooks outdoors. The stove is under an oak tree, while the pots and pans hang outside the house. This is so nearly akin to the ways of the winged fraternity that place is given to a regret that the woman is not a bird to be studied!

In spite of her zeal for bird acquaintance, the flowers do not go unobserved; two chapters are devoted to their changing glories in the wild garden of Colorado. Not only do these surpass the eastern flora in size, color, and fragrance, but also in abundance and variety. In one locality a hundred differing kinds are found in a month, and of these only half a dozen are recognized as old friends.

Altogether, a most inviting field, according to the author, awaits the naturalist in the west.

The Friendship of Nature. By Mabel Osgood Wright. New York and London: Macmillan & Co. Pp. 238. Price, 75 cents.

This little volume depicts a series of New England landscapes. They are rendered with words instead of colors, but an artist would have little difficulty in reproducing them by any medium he might choose. Foreground, background, sky, atmosphere, and foliage are delineated by the faithful eye that neglects no detail.

With the scenic descriptions are given bits of botany, ornithology, and philosophy, quaint legend, and flower lore.

Although employing a prose form, the author delights in rhythmical expression, and many sentences are as easily scanned as the following: "Down from the village runs the dusty road"; "The flush of morning comes upon the sea." Figures are lavishly scattered about; some of these are fresh and effective. Mushrooms are pictured as the gypsy race of plant-land that rears its fungus encampment. Occasionally this love of imagery betrays the author; she writes in regard to the blue gentian: "One dreams that the sky, once molting, dropped its soft-edged feathers on the grass, and earth twined them into flowers." The vision of the vaultless blue shaped like some huge fowl shedding its feathers is too incongruous to be entertained, and we dismiss it to the company of that distressing simile, "And like a

lobster boiled, the morn from black to red began to turn."

The author holds that if all were scientists the world would be badly off; spirit would be dried out by system. This is the time-worn libel upon science—science, that breathes a soul into rocks, reads the romance of flower shapes, and gets color and fragrance from a lump of coal!

Even though repudiated, science has informed much of the book with beauty, and it may be commended to country lovers as a dainty calendar of the seasons.

Alexander Winchell's Walks and Talks in the Geological Field has been adopted by the Chautauqua Circle as one of its text-books, and a special edition of the book has been made for this purpose (Flood, $1) It has been revised and edited by Prof. Frederick Starr, of the University of Chicago, who has aimed to retain all the geological material of the original edition, and in the author's own words. Marginal comment has been introduced as a convenience to the reader, and a few footnotes have been added. The editor speaks of this book as intended by its author to hold a position between text-books and books of light reading. It is written in an easy, conversational style, and is free from unnecessary technicalities. Although its forty-nine chapters have independent and picturesque titles, their scope and arrangment is such that the editor is able to group them under these general heads: surface geology, strata, igneous agencies, economic geology, fossils, beginnings of the earth, and history of life and the growth of the continent. A number of illustrations have been introduced.

A very handsome book is *Cheiro's Language of the Hand* (the author, 432 Fifth Avenue, New York, $2). It is in square octavo form, with many illustrations, and is printed with large type and wide margins. It begins with a defense, which is followed by definitions of the square, conic, and various other shapes of hands, definitions of various kinds of fingers, of the "mounts" of the hand, etc. Then follow the meanings that the author assigns to the lines, stars, and other markings on the hand. There are a number of plates at the end, showing impressions of the hands of celebrated persons, and an appendix of testimonials from persons who have had their fortunes told by the author.

The first volume of *The Tannins*, issued three or four years ago by Prof. *Henry Trimble*, has now been followed by a second (Lippincott, $2). It is devoted to the results of investigation by the author on the astringent principles from nine species of oaks and one species each of mangrove, canaigre, and chestnut. The oak barks include a species from England and one from India. A bibliography is appended, which, with that in Volume I, makes up a total of nearly one thousand titles. There are thirty-three illustrations, showing leaves, acorns, and apparatus.

The *First Lessons in Reading* of *Elizabeth H. Fundenberg* (American Book Company, 25 cents) is based on the principle that the first teaching should connect the words already known to the ear with their written or printed forms, leaving the letters and the sounds they represent to a future step. Accordingly, the sentence or word method has been adopted, to give way to the phonic-word method when the child has become familiar with the printed and written forms of a considerable number of the words which are in his oral vocabulary. The *Teachers' Edition* (50 cents) comprises a manual in which each lesson is developed, together with outlines for slate and board work; also full instructions on phonetics and rules for pronunciation and spelling.

A second edition of *Introductory Lessons in English Grammar*, by the same author, is also published by the American Book Company. This is designed for intermediate grades, and will serve better when used to supplement the preceding than if offered by itself as a first course in grammar. Although well arranged, clear, and complete, it savors enough of technicality to arouse perhaps that unreasoning distaste for grammatical study which it is better the young student should never possess.

The *Conversational Method in French* of M. J. Victor Plotton is the fruit of an experience of many years, and is a system in which successful results have been obtained by those who have used it. Its aim is to teach speaking rather than reading, and it proceeds by carefully graduated lessons to take the pupil along unconsciously, as it

were, to him, till he is expected to express himself easily in the language. The present volume is a second part, being preceded by one of a more elementary character. The lessons are arranged each to illustrate some special grammatical form, and include a passage to be read, analyzed, and questioned upon, with exercises in adapting various words to the form; and, further along, extracts from French classical authors. (Halifax, Nova Scotia, $1.)

The Daughter of the Nez Percés is a story of Indian life strictly founded on fact, by *Arthur Paterson*. Without desiring to take sides in the questions concerning the troubles in which the Nez Percés have been involved, the author's object has been to describe with what vividness he could certain scenes in the life of a chief—Joseph, still living—"who, whether right or wrong, is unquestionably one of the most remarkable men his race has ever produced." Liberties are taken with the details of Joseph's family life and some incidents not historical are admitted, but, in the main, the true course of events has been followed. Mr. Paterson's endeavor has been to present Joseph as the man he was, and not as a mere ideal of what he should have been. We have found the story very interesting. (Published by George Gottsberger Peck, New York.)

The Epitome magazine (Washington, J. B. Lockwood, manager; *M. Sewell Roy*, editor; monthly, $2 a year) is the outgrowth of the literary club life of Washington, and is expected to perpetuate the best of the essays read at the meetings. It is, however, something else than simply a club magazine, and opens its columns to discussions on all subjects of general interest. The articles in the number before us are varied, fresh, and interesting.

An excellent manual for primary schools is the *First Book in English*, by *W. H. Maxwell*. The method is inductive, the lessons short and novel in character. By observation and comparison of models the pupil learns to recognize and construct the simple sentence. Later he is taught in the same manner to identify the principal parts of speech. Practice is given in drawing and dictation as well as in composition, and with the varied drill afforded there seems no reason why a child should not easily acquire a thorough knowledge of elementary grammar and writing in even less time than the specified three years which allows for very deliberate work in a volume of 172 pages.

The New Science Review is the name of a quarterly periodical undertaken by the Transatlantic Publishing Company, Philadelphia, as a miscellany of modern thought and discovery. In outer appearance it is all that could be asked. In its "announcement" it declares that it will differ from all the scientific periodicals, not attempting to supersede the older and more conservative periodicals, but to supplement them, addressing itself not to specialists but to the public at large, presenting matter of scientific value in popular style; not assuming that the reader has an esóteric acquaintance with the matter in hand, but giving him a preliminary acquaintance with it, explaining before it demonstrates. The first number starts off with an effort of Major-General A. W. Drayson to solve the mystery of the ice age, in which he presents his theory of a second revolution of the pole under the operation of a displacement of the earth's center of gravity, under which the polar circles may be periodically brought down as low as 54° of latitude. The Problem of the Pole—that is, the present status of the attempt to reach it—is lucidly set forth by Charles Morris. Mrs. Bloomfield Moore is allowed to describe the propeller of the Keely air ship, and to glorify its projector in an article entitled The Newton of the Mind; Julian Hawthorne in another article tells how great a man Mr. Keely is; and a long and laudatory notice is given in the second number of the review of Mrs. Moore's book on Keely and his discoveries. Among other articles in the two numbers that deserve or will attract attention are Major Ricarde Seaver's Diamonds and Gold—a description of the South African mines; Lieutenant Patten's account of the eminent electrician, Nikola Tesla, and his works; a summary of Prof. Dewar's lecture on Fluorescence and Phosphorescence; the presentation by W. G. Jordan of "Mental Training—a Remedy for Education;" the Rev. John Andrews's description of the pendulograph and its curious work; symposiumlike discussions of the causes of success of certain works of fiction, the nature of electricity, and What is Science? a summary

of Charles Barnard's American Association paper on The Battles of Science; and a number of selected articles. A summary of current scientific discussion is contributed to each number by Prof. Angelo Heilprin.

The second part of the text-book on *Plane Trigonometry*, by *S. L. Loney*, deals with analytical trigonometry (Macmillan, $1). Among the topics treated in this part are exponential and logarithmic series, various operations with complex quantities, Gregory's series, and the principle of proportional parts. A list of the principal formulæ in trigonometry is prefixed to the volume, and the answers to problems are given at the end.

A treatise on *Amphioxus and the Ancestry of the Vertebrates*, by *Arthur Willey*, B. Sc., has been issued as the second volume of the Columbia University Biological Series (Macmillan, $2.50 net). The editor of the series, Prof. Henry F. Osborn, says in the preface that he suggested the course of lectures in which this volume originated, and deems it important that the author should bring within the reach of students and of specialists among other groups his extensive observations upon Amphioxus and other remote ancestors of the vertebrates, as well as the general literature upon this group.

The year ending with September, 1893, is covered by the *Eighteenth Year-Book of the New York State Reformatory*. The book contains the reports of the board of managers, the superintendent, Z. R. Brockway, the technological and military instructors, the superintendent of schools, and the physician. Instruction in thirty-four trades was imparted during the year to a total of eighteen hundred and four inmates. The trades range in character from such laborious occupations as bricklaying, iron-forging, and stone-cutting to such light and intellectual work as frescoing, music, photography, stenography, and typewriting. The year-book itself is a very creditable exhibit of the work of inmates in type-setting, illustrating, and binding. In the schools the instruction ranges from the elements of reading and arithmetic given to illiterates up to lectures in history, science, ethics, political economy, etc. For military drill the inmates constitute a regiment of sixteen companies, with a band. Appended to the reports are a chapter on dietary, one of anthropological observations with illustrations, and an account of innovations made during the year. The board of managers state that much misrepresentation of the system of the institution was made "by a sensational newspaper," and the superintendent reports that his plans for progress were much retarded by a diversion of time and attention to the investigation which followed this attack.

David T. Day's Tenth Annual Report of the Mineral Resources of the United States presents a statement of the mineral products during the calendar year 1893, the industrial conditions affecting those products, and the recent additions to the knowledge of the mineral deposits in this country. Its scope is thus similar to that of the preceding volumes, with the addition of more than the usual references to the condition of mineral industries in foreign countries. It appears from it that the total value of our mineral products in 1893 was the smallest since 1889. It represented $609,821,670, compared with $688,616,954 in 1892—a decline of 11·44 per cent. The decline in value was most conspicuous in pig iron and structural materials, but many other minerals also declined in the amount and the value of the product, the exceptions being gold, anthracite coal, aluminum, phosphate rock, and gypsum. A few other products increased in quantity but declined in value.

The thirty-fifth volume of *Annals of the Astronomical Observatory of Harvard College* contains the first part of the *Journal of Observations* made by Prof. William A. Rogers, at the observatory, to determine the places of stars in the zone between the limits of north declination 49° 50′ and 55° 10′. The catalogue resulting from these observations has already been published in the fifteenth volume of the *Annals*, and the discussion of proper motions derived from the work forms the twenty-fifth volume of the same series.

The report of the *Observations made at the Blue Hill Meteorological Observatory, Massachusetts*, in 1893, mentions as among the investigations that were carried on during the year the comparisons by Mr. S. P. Fergusson of anemometers of different types, and Mr. H. Helm Clayton's studies of the upper air around cyclones and anticyclones, as shown by cloud observations. Curious wavelike oscillations of the barograph records

at this and other stations are discussed by Mr. Clayton in the report. Connected with the observatory are a base station four hundred and forty feet below it, and a valley station six hundred feet below it. The whole of the Blue Hill has been taken by the State as a public reservation; but it is not supposed that the operations of the observatory will be interfered with by the act.

The Celestial Writing, or the Normal Script Phonetic Writing, by *W. H. Barlow*, is an abbreviated script phonetic mode of writing the English language, founded on a modified form of the consonant alphabet of Gabelsberger. It is introduced as a labor-saving device for the penman, and is derived from our common handwriting, from which the extraneous superfluities are cut off. Thus M is written with one stroke instead of three, and so on. It is claimed that the art of writing it can be acquired by a person of ordinary capacity within a week.

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Alabama. Report of the Insane Hospital at Tuscaloosa, for 1893 and 1894. Pp. 46.—Geological Map, with Explanatory Chart. E. A. Smith, State Geologist.

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Elgenmann, Carl H., and Beeson, Charles H. A Revision of the Fishes of the Sub family Sebastinæ of the Pacific Coast of North America. Smithsonian Institution. Pp. 32.

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Edwards, Rev. Jonathan. Marcus Whitman, M. D., the Pathfinder of the Pacific Northwest and Martyred Missionary of Oregon. Spokane, Wash. Pp. 48.

Fox, T. W. The Mechanism of Weaving. New York: Macmillan & Co. Pp. 472. $2.50.

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Giberne, Agnes. Radiant Suns. A Sequel to Sun, Moon, and Stars. New York: Macmillan & Co. Pp. 328. $1.75.

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Prosser, Charles S. Kansas River Section of the Permo-Carboniferous and Permian Rocks of Kansas. Pp. 54.

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United States National Museum. Baur, G. The Relationship of the Lacertian Genus Auricella, Gray. Pp. 8.—Lænnberg, Einar. Reptiles and Batrachians collected in Florida. Pp. 30.—Lucas, Frederick A. Anatomy and Affinities of Certain American Birds.—Ridgway, Robert. New Birds from Aldaba, Assumption, and Glorioso Islands, collected by Dr. W. L. Abbott. Pp. 3.—Twenty-two New Species of Birds from the Galapagos Islands. Pp. 16.—True, Frederick W. On the Rodents of the Genus Sminthus in Kashmir. Pp. 3.—Diagnosis of some Underground Wood Rats. Pp. 3.—Diagnosis of New North American Mammals. Pp. 3.—Verrill, A. E. New Species of Starfishes and Ophiurans, etc. Pp. 52.—Walcott, Charles D. Discovery of the Genus Oldhamia in America. Pp. 3.

POPULAR MISCELLANY.

A Discussion on Variation.—One of the most interesting sectional meetings of the British Association was one at which a series of papers was read dealing with questions connected with evolution and Darwinism, such as the real nature and cause of variation; the inheritance of acquired characters; the adequacy of natural selection to affect variation sufficiently to explain the great range of animal and plant structure. The first paper was by Prof. D'Arcy Thompson, on Some Difficulties of Darwinism, which was an attempt to deal with the third of these questions. Prof. Thompson suggested that the mechanical and mathematical principles of growth itself may have affected the form of animal life. He instanced the spiral shells of the nautilus and the conical eggs of the guillemot as probably deriving their shape from this principle. The second paper, by Prof. Riley, of Washington, dealt with the very interesting habits of the social insects—ants, bees, wasps, and termites—and showed how all the fresh knowledge accumulated since Darwin's time only corroborated his views, to the effect that in this case the "struggle for existence" of the colony as a whole must be substituted for that of the individual. An interesting point was made by Prof. Haycraft, to the effect that the true function of sex was to keep down variation—that by the combination of two individuals to form a new individual, a mean between the two was always obtained, and that in this way the race was kept constant; whereas, if the new individual could be produced from only a single parent, the limits of variation would be unduly extended. The other papers were by Mr. F. A. Dixey, on Some Fresh Points with Regard to Mimicry in Butterflies; and by Prof. Osborn, of New York, on Certain Variations met with in the Dentition of Fossil Mammals. Prof. Osborn showed how two teeth might come eventually to resemble one another closely, although the stages through which they passed had been widely different. The discussion which followed these five papers was of an animated character, and was participated in by a considerable number of members. Prof. Ray Lankester complained that most of the difficulties suggested had been long ago dealt with by Darwin himself, whose works were insufficiently studied by the younger generations of biologists. The discussion was finally summed up in a most lucid speech by Sir Edward Fry, who complained of the absence of clear issues, and of the consequent difficulty of forming a judgment on most of the points brought forward.

Cambodian Arithmetic.—The Cambodians have a quintesimal system of enumeration, yet they use nine digits and a cipher, and are able to count in practice about as if their system was decimal. Their methods of adding and subtracting are curious. Suppose one wishes to add the numbers 247,372, 53,723, 975,642, 278,383, the sum of which is 1,555,120. The Cambodian writes the first two numbers one above the other, draws a vertical line to the right of them, and

writes the sum, 301,095, to the right of the line. Under this number he places the third number of the series (975,642), and adds that in just as he did the first two; and so on till the process is completed. The process is longer than ours, but gives more opportunity for deliberation and the detection of errors. Where whole numbers and fractions are both involved, two series of additions are gone through. In subtraction, they write the lesser number over the larger, and begin at the left; thus, to subtract 657,869 from 786,422, they write 657,869 | 786,422 | and proceed, 6 from 10 (a fictitious number which they use for convenience) leaves 4; adding 7 (the first figure of the minuend), gives 11, and 11 — 10 leaves 1, the first figure of the remainder. For the next digits, 5 from 10 leaves 5; adding 8 gives 13; this less 1 gives 12, the first two figures of the remainder. Then, 7 from 10 leaves 3, adding 6 to which gives 9, which less 1 = 8; 10 — 8 = 2 + 4 = 6 — 1 = 5; 10 — 6 = 4 + 2 = 6 — 1 = 5; 10 — 9 = 1 + 2 = 3. Whence, if the numbers are set down as they are found, the remainder appears correctly as 128,553. In multiplication they place the multiplier over the multiplicand and multiply successively each of the figures of the multiplicand by each figure of the multiplier, obtaining a large number of partial products which they have painfully to add together. The process of division is likewise absurdly complicated.

The Utilitarian Side of Botany.—Botanists, said Prof. I. B. Balfour, in his British Association address, do not seem to have realized, except in the case of medicine, that modern botany has an outlet. Chemists and physicists seek practical aims. Zoologists help the fishing industry. But where is the practical outcome of modern botany? The work of Marshall Ward is full of purpose to many large industries, and that of Oliver has bearings on horticulture; but the trend of botanical work in England has not been utilitarian. It was, however, its utilitarian side that gave the first impetus to the scientific study of botany. The plant world, as the source of products of economic value and drugs, attracted attention, and out of this grew by natural development the systematic study of plants. The point of view was that botany was an essential branch of medical study. A practical outcome was the establishment of botanic gardens, now in many instances appendages of teaching establishments, or mere pleasure grounds. But the gardens at Kew still maintain the old tradition of botanic gardens as a center through which botany renders scientific service to national progress. Under the Darwinian influence the biological features of the plant world replaced technical diagnosis and description as the aim of teachers and workers. Pharmacy is removed from the functions of the physician; but botanical study on the lines of modern teaching is part of the university training essential to medical students. There is still danger of modern teaching being strangled by its terminology, of narrowing the field of vision and mistaking the name for the thing, of elaborating the minute details of a part at the expense of its relation to the whole organism. This mechanical attitude is a consequence of specialization. But it must be counteracted if botany is to be aught else than a mechanical study. Modern botany has not yet found its full application. It has not rendered the service due to the state. In horticulture and agriculture it should find a sphere of application by which it may contribute to the national well-being. Botanists must be the apostles of forestry; and forestry in turn will react upon their treatment of botany. Botany can not thrive in a purely introspective atmosphere; it can live only by keeping in touch with the national life.

The Uses of Illuminating Gas.—Many are the advantages of gas for household purposes, says William Paul Gerhardt, and its disadvantages are comparatively few, and for this reason it is probably more used in houses at the present day than any other form of artificial illumination. Gaslight is relatively cheap, although kerosene oil, *per se*, is probably cheaper. It is convenient, and saves domestic labor by being always ready for lighting. It is superior in point of cleanliness to oil lamps and candles. It is brilliant, easily controlled, and not difficult to manage by persons of ordinary intelligence. It is much safer than candles or lamps in which

colza oil or kerosene is burned. Gaslight, finally, creates, in proportion to the light developed, less disagreeable heat and is less unhealthful when proper ventilation of rooms is provided than candles or oil lamps. Among other purposes to which gas has in recent years been applied, Mr. Gerhardt mentions its use in warming rooms, heating sadirons, and heating water; in roasting, baking, steaming, frying, boiling, and broiling. It is adopted as fuel to drive small domestic motors, for various industrial purposes; and it is employed for artificial ventilation conducted by means of gas jets burning in exhaust flues, or by the use of sun-burners. Much has been said about the injurious influence of gaslight upon health; of the vitiation of the atmosphere of rooms; and of the destructive effects of gas, when imperfectly consumed, upon the furniture and decorations of a room, and the smoking up of ceilings and walls. But notwithstanding the rapid development of electric lighting, and notwithstanding the recent return in dwellings to the use of oil lamps, and of extensive and costly paraffin and wax candles, the use of gas in dwelling houses, offices, and stores is undoubtedly so convenient and comparatively safe that for many years to come it will constitute the chief means of artificial illumination.

Are Civilized Races Superior?—Proud of his wonderful achievements, civilized man looks down upon the humbler members of mankind. He has conquered the forces of Nature and compelled them to serve him. He has transformed inhospitable forests into fertile fields. The mountain fastnesses are yielding their treasures to his demands. The fierce animals which were obstructing his progress are being exterminated, while others which are useful to him are made to increase a thousandfold. The waves of the ocean carry him from land to land, and towering mountain ranges set him no bounds. His genius has molded inert matters into powerful machines, which wait a touch of his hand to serve his manifold demands. What wonder, asked Dr. Franz Boaz, in his address before the Anthropological Section of the American Association, that he pities a people who have not succeeded in subduing Nature, who labor to eke an existence out of the products of the wilderness; who hear with trembling the roar of wild animals; who remain restricted by ocean, river, or mountains, and who strive to secure the necessaries of life with the help of few and simple instruments? What wonder if civilized man considers himself a being of higher order than primitive man? If it is claimed that the white race represents a higher type than all others? When we analyze this assumption it will soon be found that the superiority of the civilization of the white race is not a sufficient basis for it. As the civilization is higher, we assume that the aptitude for civilization is also higher, and as the aptitude for civilization presumably depends upon the perfection of the mechanism of body and mind, the inference is drawn that the white race represents the highest type of perfection. In this conclusion, which is reached through a comparison of the social status of civilized man and primitive man, the achievement and the aptitude for achievement have been confounded. Furthermore, as the white race is the civilized race, every deviation from the white type is considered a characteristic of the lower type. That these two errors underlie our judgments of races can easily be shown by the fact that, other conditions being equal, a race is always described as the lower the more fundamentally it differs from the white race.

The Problems of Archæological Relics.—The purpose of Mr. Gerard Fowke's Notes on the Archæology of Ohio is to present in a compact form conclusions based upon a careful study of the earthworks and the relics associated with them; embodying a summary of the results reached by all who have been engaged in the investigation. The very wide range of forms and relics—as is shown by the author—the diversity of material, and their unlikeness to almost everything belonging to the present inhabitants, have caused some misapprehension or confusion as to their probable uses. This is especially the case with the great number of objects whose manufacture may be considered the outcome of æsthetic or religious ideas. They are made of nearly all the different kinds of shell, bone, metal, and stone, especially slate and steatite, accessible to their fabricators. Under such names as gorgets, crescents,

wands, tubes, banners, stones, amulets, pendants, butterfly gorgets, ear bobs, bracelets, breastplates, beads, buttons, headdresses, labrets, nose rings, charms, and a score of others, they are delineated in many volumes. To ascribe a purpose to any pattern, unless a similar one has been seen in actual service, would be as presumptuous as the attempt by a person entirely ignorant of modern secret societies to explain the meaning of badges, pins, or regalia. No doubt some of them owe their form to a whim or fancy of the maker; others were purely decorative; while many of them were symbolic, or for use in the manifold dances, parades, celebrations, superstitious ceremonies, and other observances so dear to the minds of an uncultured people. The manner of perforation in some indicates that they were for suspension by cord; in others, that they were to be placed upon a staff; still others, unperforated, may have been secured in various ways. Nearly all are made of material that would break if carelessly handled; many are of such size or shape that no particular use for them can be imagined. There is less trouble in regard to the utensils, weapons, or implements for ordinary work, comprising articles necessary in agriculture, hunting, warfare, or domestic affairs. What sort of work the prehistoric people may have done in wood, textile fabrics, feathers, fur, robes, skins, or other perishable material, can never be known; but judging from the few scraps remaining, and from such other specimens as have been preserved, it was probably on a par with that of the present day among tribes but little changed from their condition when first known to the whites. Mr. Fowke's notes are published, with plates, by Robert Clarke & Co., Cincinnati.

Roger Bacon's Dream of Steam and of Air-Ships.—An essay by Roger Bacon, published in 1618, has been brought to attention by M. de Fonvielle, which contains dim predictions of steam power and the navigation of the air. "Instruments," the author says in this essay, "may be made for navigating without any men pulling the oars, with a single man governing, and going quicker than if they were full of pulling men. . . . Wagons can also be made, that without any horse they should be moved with such a velocity that it should be impossible to measure it. . . . It is possible also to devise instruments for flying, such that a man being in the center if revolving something by which artificial wings are made to beat the air in the fashion of birds. . . . It is also possible to devise instruments which will permit persons to walk on the bottom of the sea. . . . All these things have been done in old times and in our times, except the instrument for flying, which I have not seen, and I have not known any man who saw it done."

The Test of Exactness.—Admitting that the prevailing opinion that great advances have recently been made in astronomy is correct so far as the fields of spectrum analysis and the measurement of minute quantities of radiant heat are concerned, Dr. William Harkness showed in his vice-presidential address at the American Association that the solution of the vast majority of astronomical problems depends upon the exact measurement of angles, and in that little or no progress has been made. Bradley, with his zenith sector a hundred and fifty years ago, and Bessel and Struve, with their circles and transit instruments seventy years ago, made observations not sensibly inferior to those of the present day, and indeed it would have been surprising if they had not done so. The essentials for accurately determining star places are a skilled observer, a clock, and a transit circle, the latter consisting of a telescope, a divided circle, and four micrometer microscopes. Surely no one will claim that we have to-day any more skillful observers than were Bessel, Bradley, and Struve, and the only way in which we have improved upon the telescopes made by Dollond one hundred and thirty years ago is by increasing their aperture and relatively diminishing their focal distance. The most famous dividing engine now in existence was made by the elder Repsold seventy-five years ago; but, as the errors of divided circles and their micrometer microscopes are always carefully determined, the accuracy of the measured angles is quite independent of any small improvement in the accuracy of the divisions or of the micrometer screws. Only in the matter of clocks has there been some advance, and even that is not very great. On the whole,

the star places of to-day are a little better than those of seventy-five years ago, but even yet there is great room for improvement. One of the commonest applications of these star places is to the determination of latitude, but it is very doubtful if there is any point on the face of the earth whose latitude is known certainly within one tenth of a second. Looking at the question from another point of view, it is notorious that the contact observations of the transits of Venus in 1761 and 1769 were so discordant that from the same observations Encke and E. J. Stone got respectively for the solar parallax 8·59 seconds and 8·91 seconds. In 1870 no one thought it possible that there could be any such difficulty with the contact observations of the then approaching transits of 1874 and 1882, but we have found from sad experience that our vaunted modern instruments gave very little better results for the last pair of transits than our predecessors obtained with much cruder appliances in 1761 and 1769.

Women in the Higher Education.—The facts presented in a special report on women's education, given in the University Convocation Proceedings for 1893, show that women are gaining in every educational field. The secondary schools of the State returned in that year 23,556 girls of academic grade to 18,243 boys; and of 438 honor credentials issued, 298, or more than two thirds, were to girls. The number of women in colleges had risen to 2,923, of whom 2,078 were in the eight specifically women's colleges, besides 880 in subfreshmen classes. The professional and technical schools returned 4,043 women, and the special schools 3,308. The number of girls entering college from regents' schools was eighty-four per cent greater than the year before, and the increase promised to continue in the current year. Of the teachers in the New York common schools 28,869 were women. In the United States there were in 1890, 125,525 men and 238,397 women teachers. Two years later the number of men had decreased 3,974, and the number of women had increased 14,383. Women are more and more employed as teachers in the grammar and higher schools and in colleges and the university; more of the graduates from women's colleges are entering the medical profession; progress is making in the legal education of women; and opportunities are now offered them to take a theological course.

An Old Book of the Weather.—The first of a series of reproductions of old books on meteorology and terrestrial magnetism undertaken by Dr. D. Hellmann, of Berlin, is the *Wetterbüchlein*, or Little Book of the Weather, of L. Reyman, the oldest German book on meteorology. It was published at Augsburg in 1505, and passed through seventeen editions in thirty-four years. It has also been translated into English. It is essentially an elementary manual for foretelling the weather from the rudimentary data which the science of the time possessed. The barometer and thermometer were not known, and the principal rules found in Reyman's book are drawn from the appearance of the sky and clouds, the optical phenomena of the atmosphere, the direction of the wind, the phases of the moon, and other like signs. Most of them were known to the ancients and the Arabs, from whose writings the author has derived them—expressing them always concisely and intelligibly to the public. The book is much superior in scientific character to the weather-predicting almanacs of our time; for, instead of pretending to foretell the weather a year in advance, as they do, it has simply given the signs by which its course may be foreseen a short time in advance.

Play and Study.—In a paper on Child Study in Summer Schools, President G. Stanley Hall observes that practically we have to act as if there were no such thing as pure thought. Children have no thought without motion. Motion and thought go together, and if you make them sit still they can not think. Their minds will not move unless their bodies move along with them. We weaken thought if we try to eliminate motion. In the child study at the summer school one thousand children's games were selected and studied, then arithmetic games and geography games, and those that gave strength to the shoulders and hips, "and we had everything that was taught in the whole grammar course without any exception and a good deal more. We cut down these games to one hun-

dred and fifty or two hundred, and found that everything could be taught by historic plays and games. Then we began the history of games, and found that education used to be play, and now it has become hard work. A little while ago older people used to play. It was the spontaneous activity. We have composed a programme of all the school studies taught only by plays and games. I won't say that it is yet practicable; I simply say it can be done. It shows that spontaneities have done everything, just as in the world everything we know has originally been spontaneity, either of geniuses or great discoverers or inventors. I do not go so far as some enthusiasts, but we are realizing that everything in Nature is to be found in the child. Nations as well as associations, institutions as well as colleges and schools, religions and everything else, when judged by the highest standard of right and wrong, will be pronounced good or evil exactly in proportion as they have ministered and conformed to the nature and needs of childhood, adolescence, and growth. That civilization, that school, that college, is best that has devised the most efficient methods for this."

A White Bear's Bath.—The bath of the younger bear in the London Zoölogical Gardens is thus described in Mr. C. J. Cornish's recently published Life at the Zoo: "Fresh water is let into the bath two or three times a week, and as soon as the bottom is covered the younger bear rolls in and 'cuts capers,' to use the keeper's phrase. She always prefers to take a 'header,' but not after the orthodox fashion; for when her nose touches the bottom she turns a somersault slowly, and then floats to the surface on her back. Then she climbs out, shakes herself, and gallops round the edge of the bath. In spite of her bulk, this bear is as active as a cat, and can go at speed round the circle without pausing or missing a step. Her next object is to find something to play with in the water. Anything will do; but if nothing else is handy, she usually produces a nasty bit of stale fish, which she seems to keep hidden in some handy place, and dives for it, coming up to the surface with the fish balanced on her nose, or on all four paws. If the water is still running in, she will lie under the spout, and let it run through her jaws. But the most amusing game which the writer has seen was played with a large round stone. After knocking it into the water and jumping in to fish it out, she took it into her mouth and tried to push it into the hole from which the water was still running. This was a difficult matter, for the stone was as large as a tennis ball, and the pipe was not much wider. Several times the stone dropped out, though the bear held it delicately between her lips and tried to push it in with her tongue. At last she sat up and, holding the stone between her fore paws, put it up to the pipe and pushed it in with her nose. This was a great triumph, and she retired and contemplated the result with much satisfaction. Later, being apparently tired of this achievement, she threw water at it with her head, and, failing to wash it down, picked it out with her claws and went on diving for it in the bath."

Nature's Commerce.—Even before the first human commerce Nature, as Prof. O. T. Mason shows in his Technogeography, had her great centers of superabounding material, and took pains to convert this excess into supply against scarcity. Thus, all over the earth bees gather honey from ephemeral plants that man can not eat, and store it away in enduring form to be used in time of need. In certain regions of California the piñon seeds grew so abundantly that the Indians could not gather them; but the squirrels laid them up in vast quantities, fed on them in winter, and were themselves eaten by the savages at a time when meat diet was most necessary. They thus gave the Indians a lesson in economy and storage. As an example of the way in which Nature uses the excess of one locality to supply the dearth of another locality, Prof. Mason cites the case of the wild rice, which covers thousands of acres in some places along the Great Lakes and feeds millions of waterfowl. These same creatures are the source of food for the Eskimos, who never saw a spear of grass or ate a mouthful of vegetable diet. Seeds of plants enter into migration by a natural transportation through rivers and ocean currents, by means of winds and the agency of birds, and set up in their progeny new centers of supply on distant shores. The most marvelous of these commercial enterprises

of Nature is that in which she converts apparently inaccessible and unutilizable material into inexhaustible supplies for every industry of man. A wonderful example of this is found in the littoral feeding grounds. There is a bench of land under the sea skirting every shore and reaching under all estuaries. It is not deep. Indeed, it is the connecting link between the land and the profound sea. Upon this plateau the *débris* of the fertile lands and of the fresh waters is daily poured, and myriads of the lower plants and animals are developed. Here are nourished cod, shad, herring, salmon, oysters, clams, and so on. The fish after attaining maturity actually swim up to men's doors to be captured. Also upon this feeding ground are nourished the sea mammals which have been indispensable to the life and happiness of our northern aborigines. It is true that every useful plant is converted by Nature out of material which men can not use. Long before Texas cattle were bred in one place and driven hundreds of miles to market Nature reared fish and walrus upon her enormous pasture lands under the sea and drove them to market herself.

Effects of Occupation on Eyesight.—The effects of certain occupations on eyesight are manifested, according to Mr. Simeon Snell, who has made a study of the subject, in a variety of ways. Workers in India-rubber factories are troubled by the fumes of bisulphide of carbon, which is used in the vulcanizing process. The vapor of this substance was formerly employed as an irritant of the conjunctiva and a promotive of abundant lachrymation, and it tends to produce amblyopia. Amblyopia, or dullness of vision, is brought about in the manufacture of explosives by dinitro-benzyl. While the toxic action of tobacco when chewed seems to be established, the assertion that persons working in tobacco factories are subject to disorders of vision has not been confirmed. The prejudicial action of lead is well known, but to the usual experiences in the matter Mr. Snell adds the curious instance of amblyopia produced among the file-cutters of Sheffield by inhalation of the particles of lead that fly off from the lead bed on which the file is laid to be struck. The statements that glass-blowers are subject to cataract from exposure of their eyes to the intense heat and light of the furnaces are not supported by the later observations. Mr. Snell has found that men can look at metal in the furnace with comparative ease, so long as its temperatare is not greatly above 2,000° F.; but when it approaches 3,000° F. they have to wear colored glasses. At cast-iron furnaces, where the heat of the metal is between 1,800° and 2,000°, the men take no special precautions; but the heat of molten steel is between 2,700° and 2,800°, while the heat of the gases in the furnaces would be about 200° or 300° more, and the men in attendance have to wear dark-blue glasses to protect their eyes. The heat of the metal in the Bessemer process is greater still, increasing to 3,000° or 3,200°, but the metal does not have to be so long or so carefully watched as in the Siemens furnace. In none of these cases has Mr. Snell been able to associate any deep or superficial eye lesion as the result of exposure to intense light and heat. Exposure to the light employed in electric welding causes sharp conjunctivitis, with great pain and tear-shedding, and, if it be allowed to enter the eye, optic neuritis, with retinitis and a central scotoma in the vision. The effects are due to the chemical rays, and the men are obliged to use screens made of dark ruby, non-actinic glass.

Geological Work of the Atmosphere.—Believing that too little attention has been given by American geologists to the work performed by the atmosphere in erosion, transportation, and sedimentation, Prof. J. A. Udden, of Augustana College, has considered the subject in a brief paper. He begins by assuming that as an agent of erosion air is far less efficient than water—because of its small weight, it being only $\frac{1}{815}$ as heavy as water, and because it exerts no wave motion on the surface of the earth. The erosive action of wind therefore becomes important only in certain localities, under the favoring conditions of a dry climate and a topography of abrupt and broken reliefs. Since the speed of the wind is lowest near the surface of the ground, materials to be transported any considerable distance by the atmosphere must be by some means lifted through and over this zone of low velocity. This condition is furnished by whirlwinds and reliefs which cause

eddies or give the wind an upward direction. To be subject to transportation by the atmosphere, rock materials must be finely comminuted; and the author has ascertained by experiment that the average largest diameter of quartz particles that can be sustained in the air by ordinary strong winds is about one tenth of a millimetre. But the capacity of the air for transporting particles below this size is very great, and is estimated to be per cubic foot at an average velocity of five miles an hour, one thousandth that of water. The whole atmosphere over the Mississippi Valley, if the wind blows ten times as fast as the river runs, may transport one thousand times as much dust. Atmospheric currents being loaded, for the most part, only to the extent of an insignificant fraction of their capacity, their sediments will be better sorted —the fine material will be more completely separated from the coarse—than deposits from water currents, which are more often loaded to their full capacity. That deposition of dust will take place where wind is caused to slacken its speed is self-evident, and is observed every day in the accumulation of dust on the windward side of a closely built-up street.

Boarding Schools and Infection.—The Agency of Boarding Schools in Disseminating Infectious Diseases was the subject of a paper by Dr. Clement Dukes at the Congress of the British Institute of Public Health. The author charges boarding schools with not having exercised sufficient care in the protection of society against sanitary detriment from influences they might control. The conditions of boarding schools, with their regular vacations and occasional leaves of absences, are such that there is almost a perpetual to-and-fro communication between them and the home. Then, when pupils become ill they are sent home, if practicable; and when general illness breaks out in the school, those who have as yet shown no symptoms of it, or only the beginnings of them, are sent home. These pupils, possibly bearing the seeds of infection, travel in the public conveyances in contact with unsuspecting passengers, or to be followed by such, to whom disease may be communicated. The spread of infectious diseases by boarding schools is admitted to be, unfortunately, to a certain extent, necessary by virtue of the existing system and the susceptibility of the pupils. Beyond this, such diseases are often disseminated ignorantly and thoughtlessly by the operation of motives in which such result is not contemplated, or wantonly. As remedies for the evil the author suggests bills of health to be given by parents on sending their children to school and by teachers on sending pupils home; and that schools should make adequate provision for the treatment of illness of their pupils and for the retention of all patients till they are absolutely free from infection.

Mistaken Diagnoses.—Common Diseases Mistaken or Mistreated is the subject of an address recently delivered before a medical society by Dr. J. F. Goodhart, of Guy's Hospital. It concerns the diagnosis and treatment in every-day practice of cases which practitioners must see regularly, which are yet frequently mistaken and mistreated. Infantile scurvy, for instance, is a very common complaint, but is often not recognized, and allowed to pass as rickets or rheumatism, or injury, or temper. Another disease which, although very common, varies much in severity and in the mode in which the pain manifests itself, is angina pectoris. It is often mistaken for indigestion, neuralgia, rheumatism, flatulence, etc., and fatal results have often followed from the wrong treatment having been adopted. Other instances of error occur in the confusion of the passage of urates with that of uric acid, in the adoption of a rigid form of dieting to get uric acid out of the system, when it is the individual that should be treated, and his malady, individualized in him, through him; and in the treatment of renal colic and chlorosis. The author emphasizes the fact that many of the methods and aims of medicine are faulty by reason of the ready assumption that their bases are unassailable; that men are constantly driven back upon their own experience, and compelled not to accept it but to question it.

Tests for Old Plumbing.—The tests usually applied in inspecting old plumbing work, as named by William Paul Gebhard, are the peppermint test, the smoke test, and sometimes an air-pressure test. The water test is not practically applicable to plumbing work in actual use, because it necessitates the dis-

connecting of all fixtures, and even then there is risk in applying it of flooding parts of the house. "The peppermint test is useful in a measure, but unless great care is taken in applying it the results are at times misleading. It is, therefore, in the hands of inexperienced or unscrupulous persons a rather dangerous and somewhat objectionable test. It is not always possible to define by it the exact position of the leak, or to determine exactly what the defect is. In the more positive smoke test, on the other hand, any leakage becomes apparent to the senses of smell and sight; in fact, in nearly all cases, except where leaks are very slight, the issue of smoke will indicate the exact point at which plumbing is unsafe. In order to have continued assurance that the plumbing and the drainage and the gas-piping remain safe, it is advisable to repeat the tests from time to time. The walls of a building settle, the pipe joints may become untight, or the joints may open by expansion when much hot water passes through the waste, or pipes may break, or traps may sag or tip over, rubber gaskets of floor joints may disintegrate and rot, leaving open cracks through which sewer air may pass, or joints made with brass couplings may become loose, and rubber or leather washers may rot; in short, there are numerous points which in a plumbing system may become defective after it is in use for some time. Hence the necessity of periodical re-inspection, which is just as desirable with plumbing work as it is with steam boilers or other machinery."

The Electric Arc.—In a lecture at the Royal Institution on Electrical Illumination Prof. J. A. Fleming exhibited the formation of an arc between carbon rods, and said that it had been experimentally proved that the arc could not be started unless either the rods were first brought into contact or the insulating power of the air between was broken down by an electric spark. An immensely magnified image of the arc was projected on the screen, so that its interior structure was rendered visible. It was seen, for instance, that the positive carbon rod becomes most intensely hot at the extremity and hollowed out into the form of a crater, from which about eighty per cent of the total light is emitted. The negative carbon does not become so hot. The space between the two, or the true arc, is filled with vapor of carbon. In the central space a brilliant violet axis is seen, violet being the color of incandescent carbon. Outside this is an aureole of carbon vapor of yellow or golden color. With the use of a prism the central axis of the arc gave a spectrum marked by two brilliant violet bands. It was next shown that the rise of electric pressure in the arc takes place chiefly at the surface of the crater, which is in fact the place where the work is done in evaporating the carbon. The light emitted is therefore due chiefly to the incandescence of the carbon in the crater. Hence the light is not given off equally in every direction. It is most intense in that direction in which the largest area of crater can be seen.

Humming Birds as Carriers of Pollen.—The agency of humming birds in transferring pollen from flower to flower is shown in a paper by Joseph L. Hancock to be parallel in importance with that of insects. The common ruby-throated humming bird, though it is not endowed with specialized structures for the specific performance of this office, has in its mouth parts and feathers means for harboring the pollen. The anatomical peculiarities of its head permit access to flowers of a wide range of forms. The bill, by virtue of its flexibility, is capable of probing to the bottom of most of the common forms of flowers; and in the feeding process the flower is often bent over. The various ways in which pollen is carried to this bird were revealed on microscopic examination of some dead specimens. On the lower mandible just in front of the angle of the mouth, overshadowed by the nasal scale when the bill is closed, a faint yellowish line marks the deposit of pollen grains resting, clustered together, in a small groove. Pollen grains work their way free to the summit or vanes of the feathers, and are caught up by the barbs of the feathers along the sides of the chin and lores, where they remain ready to be deposited when a more suitable surface is presented. A second receiver of pollen is the deep median groove under the lower bill, the point of meeting of the rami. Four ways have been observed by the author in which pollen becomes engaged or held by the feathers. In flowers, the pollen of which is

carried by the wind, the grains are small, light, and more or less dry and spherical; in flowers in which it is carried by insects they are variously adapted to adhere to the under side of the carrier's body; in those whose pollen is distributed by birds it is carried in so various ways that this circumstance combined with other data indicate the possibility of the humming bird being the most wonderful distributor of pollen known to the animal world.

In an Engineering Laboratory.—The work of an engineering laboratory, observed Prof. A. B. W. Kennedy in his British Association address, is in intention and in essence different from that of the physical laboratory. The aim of the latter is to make its problems as simple as possible, to eliminate all disturbing elements or influences, and to obtain finally a result which possesses the highest degree of absolute accuracy. In most physical investigations the result aimed at is one in which practical absolute accuracy is obtainable, although attainable only if infinite pains be taken to get it. It is the business of the physicist to control and modify his conditions and to use only those which permit of the desired degree of accuracy being reached. In such investigations it sometimes becomes almost immoral to think of one condition as less important than another. Every disturbing condition must be either eliminated or completely allowed for. That method of making the experiment is the best which insures the greatest possible accuracy in every part of the result. The business of the engineer, on the other hand, is to deal with physical problems under conditions which he can only very partially control, and the conditions are a part of his problem. Perhaps the whole matter may best be summed up by saying that in a physical laboratory the conditions of each experiment are under the control of the experimenter and are subservient to the experiment. In an engineering laboratory the conditions form part of the experiment. Whenever the whole matter seems to be mastered from one point of view, it is only to find with a little more experience that from another point of view everything looks different and the whole criticism has to be started afresh. Machines can not be finally criticised—that is to say, they can not be pronounced good or bad simply from results measurable in a laboratory. One wishes to use steam plant, for instance, with which as little coal shall be burned as possible; but clearly it would be worth while to waste a certain amount of coal if a less economical machine would allow a larger saving in the cost of repairs, or it might be worth while to use a machine in which a certain amount of power is obviously lost if by means of such a machine the cost of attendance can be measurably reduced.

NOTES.

A SOUTH JERSEY Woodmen's Association has been formed, with headquarters at May's Landing, N. J., the objects of which are stated to be to improve and protect the forests of the southern counties of New Jersey; to prevent all wanton and needless destruction of forests; to adopt such methods of cutting as will increase and prolong the yield of timber and cordwood; to insist upon the enforcement of the laws in relation to forests and the punishment of malicious and careless fire-setters; to encourage the planting and seeding of valuable trees on Jersey waste land and elsewhere wherever practicable; and to encourage such methods of forest management as will tend to conserve and increase our water supply and protect the wild animals of the woods. A monthly pamphlet—The South Jersey Forester—is to be published as the official organ of the association.

A NEW species of giraffe has been discovered in Somaliland by Major Wood, of the British army, who has killed one specimen and seen seven others. It is distinguished by a complete and whole body covering of rich bright chestnut, hardly separable by very fine, almost invisible, lines of creamy white.

OF garden vegetables described by Prof. Bailey in a Bulletin of the Cornell Agricultural Experiment Station, the cabbage, Pe Tsai, is described as a plant with a loose, lettucelike head of crisp leaves, which may be used in the same way as cabbage. A mustard producing an enormous quantity of herbage is excellent for greens. California pepper grass is apparently a finely cut leaved form of mustard, and is an excellent plant for spring greens. Other mustardlike plants are the Pak-Chol, used as greens and for the thick white leaf stalk, and the tuberous-rooted mustard grown for its small turniplike root. The fruit of the wax gourd, Zit-Kwa, is excellent for conserves. The La-Kwa, or momordica, has merit as a curiosity and an ornamental vine. The Luffas, or dish-

cloth gourds, are of two species, and yield a spongelike fiber useful for household purposes.

THAT was a curious objection to the use of anæsthetics in surgery, and especially in midwifery practice, that is recorded as having been urged by some clergyman in the early days of chloroform. The reverend gentleman denounced the drug as "a decoy of Satan, apparently offering itself to bless woman, but in the end it will harden society and rob God of the deepest cries which arise in time of trouble for help." The religious objection was based on Genesis, iii, 16. To us such a plea for perpetuating pain sounds too quaint for serious argument; but Sir James Simpson set himself to prove that the word translated "sorrow" is really "labor," "toil."

AN appropriation has been made by the American Association for the maintenance of an investigator's table at the Biological Laboratory of Cold Spring Harbor. The table will be held under the same conditions as that at Woods Hole—namely, the persons applying must either be, or must subsequently become, members of the American Association, and must be accepted by a committee of the association which has been designated for the purpose. Applications for the table for the ensuing year should be made to Prof. H. W. Conn or to Prof. Hooper.

THE Copley medal of the Royal Society has been awarded for 1894 to Dr. Edward Frankland for his eminent services to theoretical and applied chemistry; the Rumford medal to Prof. James Dewar for his researches on the properties of matter at extremely low temperatures; the Royal medals to Prof. Joseph John Thomson in recognition of his contributions to mathematical and experimental physics, especially to electrical theory, and to Prof. Victor Alexander Haden Horsley for his important investigations relating to the physiology of the nervous system and of the thyroid gland, and to their applications to the treatment of disease; the Davy medal to Prof. Cleve, of Upsala University, for his researches on the chemistry of the rare earths; and the Darwin medal to Prof. Huxley for his researches in comparative anatomy, and especially for his intimate association with Mr. Darwin in relation to the origin of species.

FROM Predmost, near Prerau, in the Austrian Empire, where large numbers of bones of the mammoth have been found in the past, comes a report of the discovery by Conservator Maschka, of Teltsch, of the well-preserved fragments of "the skeletons of a whole diluvial family of six persons." The skeleton of the man is wonderfully complete, and is of gigantic proportions. If this find is adequately verified, it will afford a contradiction to the assertion of the Danish expert, Steenstrup, that no man lived upon the earth at the same period as the mammoth.

THE experiments of Drs. Petri, Kolb, and Friedrich, who inoculated one hundred and seventeen guinea pigs with dust collected in railway carriages, and who also examined the dust bacteriologically, have proved that it contains pathogenic germs. How admirable are the arrangements of railway passenger cars for collecting this dust and setting it flying into the lungs of travelers! The case calls for reform and for the provision of seats and car trimmings that will not so readily collect the dust and may be more easily cleansed than the usual plush cushionings.

THE first steps have been taken for the organization of a society for the purpose of scientific research in the State of Michigan, to be known as the Michigan Academy of Sciences. At a meeting held in Ann Arbor, June 27th, a list of officers was chosen, with W. J. Beal as president, to serve and act as an advisory board till a permanent organization can be effected; and a meeting for the latter purpose is to be called some time during the winter. The suggested plan of work for the society is comprehensive, and is capable of enlargement as occasion may require.

A SOCIETY of Friends of French Explorers has been established in Paris in affiliation with the French Geographical Society. It contemplates the foundation of a fund in aid of explorers and assistance in the publication of the scientific results of their researches.

IN Brittany, when foreign substances get into the eye, the sufferer calls one of his friends to his relief, who gently licks out the grain with his tongue. A similar practice is in use among the doctors of Annam, who employ the tongue for conveyance into the eye afflicted with purulent conjunctivitis the healing powder which is their specific for the disease.

M. DESPREZ, of Saint-Quentin, France, suggests as an improvement in shoeing horses the interposition of a cushion of gutta percha between the shoe and the hoof, to give elasticity and nullify the shock of the incessant blows on the stone of the pavement.

A NEW disease has appeared among horses in Australia grazing in the pastures along the Darling River. It is manifested by a gradual weakening of vision, ending in its extinction. Its origin is traced to eating the leaves of a native tobacco plant (*Nicotiana suaveolens*). The plant has only recently appeared in the region, where it has originated from seeds brought down by freshets from near the sources of the river. Its growing abundance and the prevalence of the eye disease seem to be coincident.